

1st International Conference on Applied Operational Research

ICAOR'08 ABSTRACTS

eBOOK OF ABSTRACTS

Yerevan, Armenia

15 – 17 September 2008

ICAOR 2008 eBook of Abstracts
Edited by Kaveh Sheibani

ISBN 978-964-04-2178-9

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1st International Conference on Applied Operational Research (ICAOR'08)

The conference is a yearly forum which brings together academics and practitioners from around the world with an opportunity to discuss the most recent developments in the area of operational research with particular emphasis being placed on applications.

1st International Workshop on Scheduling in Healthcare Systems (SCHEALS'08)

Many Healthcare providers have suffered a crisis of poor quality and inefficiency with rapidly increasing costs. Healthcare delivery faces complex scheduling needs and stands to gain from advances in scheduling technology and understanding. The purpose of this workshop is to provide academics and practitioners an opportunity to share the most recent developments in the area of scheduling in healthcare systems.

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Preface

The International Conference on Applied Operational Research (ICAOR) is an annual forum bringing together academics and practitioners from around the world to discuss the most recent developments in operational research and management science (OR/MS). The conference covers all aspects of our subject, but with a particular emphasis on applications. This year, the first event in our planned series of conferences – ICAOR 2008 – takes place at the American University of Armenia in the city of Yerevan. It is organised by Tadbir Institute for Operational Research, Systems Design and Financial Services. We received a large number of submitted papers, much more than we had expected for our first gathering, from 26 countries around the world. We finally accepted 36 submissions for presentation at the conference.

We very much hope that you will enjoy the conference programme and the planned social events. We wish you all a very pleasant stay in Yerevan and trust that you will find the conference to be of value and leave us having made many new friends.

Dr. Kaveh Sheibani
ICAOR Chair in General
August 2008

The Home Care Crew Scheduling Problem

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Abstract. The Home Care Crew Scheduling Problem emerges in modern healthcare systems. The idea of home care is to offer a variety of services in the homes of the patients, whenever this is possible. A number of nurses and other personnel go from home to home and provide the necessary service. The Home Care Crew Scheduling Problem deals with the assignment of visits to caretakers and the scheduling of the visits. The objective of the mathematical optimization is to provide a higher level of service at a reduced cost. The problem is modeled as a set partitioning problem with side constraints and related to the vehicle routing problem with time windows, where this methodology has previously shown convincing results. The model is implemented using column generation in a Branch-and-Price framework and tested on four realistic test instances. The schedules generated are significantly better than the ones currently used in practice.

On Modelling and Solving Nurse Rostering and Reroostering Problems

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Abstract. The nurse rostering and the nurse reroostering problems are important phases in the human resources planning process of hospitals. The quality of care to patients, efficiency and the satisfaction of personnel depends on the adequate solution to these problems. In this paper the two problems are modeled as a unique integer multi-commodity flow bi-objective problem. Since both real life situations amount to difficult combinatorial optimisation problems, they can, as is usual, be tackled by exact methodologies when the instance dimension is low, otherwise non-exact methodologies are employed. By taking a set of real-based instances, the performance of a goal programming approach will be computationally compared with that of a genetic heuristic custom designed for these bi-objective problems.

A Tabu Search Algorithm for Solving a Transportation Problem of Patients between Care Units

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Abstract. In a hospital environment, patients have to be transferred to another hospital or another care unit. Patients may also be taken at home or brought from the hospital back home. For the Hospital Centre of Tours (France), the response to this transportation demand, which is partially known in advance, is ensured by the staff and vehicles of the Hospital Centre managed by the ambulance central station. The demands are not all equivalent since some of them require specific vehicles. The purpose is to satisfy the transportation demands with minimum cost. We propose an integer linear programming formulation and a Tabu Search algorithm for solving the problem. Computational results show the efficiency of the method.

Heuristics and Support for the Solution of Street Routing Problem

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Abstract. Servicing a large number of customers in a city zone is often a considerable part of many logistics chains. The capacity of one delivery vehicle is limited, but, at the same time, it usually serves a large number of customers. This problem is often called a Street Routing Problem (SRP). Key differences between Vehicle Routing Problem (VRP) and SRP are presented here. As presented, only using systems such as Geographical Information Systems (GIS) it is possible to effectively manage SRP. Besides classical measurements used in VRP, other, mostly qualitative, measurements are presented. All of these are named as visual attractiveness. Several new heuristics for solving SRP are evaluated on the real data and then compared. One of the key properties of GIS for use with the routing software is its flexible interactive and user-friendly environment. Paper presents a practical use of new heuristics with the ArcView and solution of address mail for several cities in Slovakia served by Slovak Post ltd. Other Decision Support Systems that solve SRP are presented as TRANSCAD developed by Caliper Corporation or GeoRoute developed by Canadian Post and GIRO.

Application of Selected Heuristic Methods on SDVRP

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Abstract. The paper deals with a split delivery vehicle routing problem, which is a modification of a vehicle routing problem. It consists in delivery routes optimization in communications network containing initial city of all routes and a given number of places, which is necessary to include in delivery routes, where a customer can be served by more than one vehicle. The objective is to find a set of vehicle routes that serve all the customers and the total distance traveled is minimized. The split delivery vehicle routing problem is NP hard, therefore we present a solution approach by three heuristics, and a metaheuristics called ant colony optimization (ACO).

Approximate Covering Models of Location Problems

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Abstract. There are two main computer-supported approaches to public service system design. The approaches differ in used quality criteria and the associated models. If the quality criterion does not include relation between a served customer and a servicing facility (e.g. a distance) explicitly, then the problem can be usually modeled as a covering problem and it can be solved quickly by a commercial IP-solver. On the contrary to this favorite case, the location problems, criterion of which takes into account individual distances, are modeled by so-called location-allocation models. Only special algorithms can solve large sized instances of the latter problems and the associated computational times often exceed any admissible limit. A new modeling approach to these bad-solvable problems is presented in this contribution. This approach is based on a specific reformulation of an allocation model to generalized covering model, which consists of less variables than the allocation one and preserves the properties, which enable its fast solving using a standard IP-solver. As a loss of preciseness is paid for this easier solvability, three big instances of the problem were chosen to demonstrate suitability of the approach and to find a relation between size of the instance, preciseness and computational time.

A Variable Neighborhood Search Method for a Flowshop Scheduling Problem to Minimize Makespan

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Abstract. In this paper, we present a variable neighborhood search (VNS) method to tackle a flowshop scheduling problem that minimizes makespan. Our proposed VNS incorporates three advanced neighborhood search structures (NSS) together with a framework of the variable neighborhood descent (VND) that is a special version of the VNS. The NSS is generated by the means of insertion neighborhood in our proposed VNS. To evaluate our proposed VNS, a benchmark is set to compare the VNS against some other high-performing algorithms in the literature, which have proved their effectiveness. The related results illustrate that our proposed VNS works better than other algorithms considered in this paper.

A Very Fast Heuristic for Job-Shop Scheduling Problem Minimising the Mean Total Completion Time

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Abstract. This paper introduces a new fuzzy greedy heuristic (FGH) for the job-shop scheduling problem (JSP) with the mean total completion time (MTCT) criterion. The heuristic consists of two phases: building a candidate list of operations, and constructing a schedule. The candidate list is formed from all possible unscheduled operations, each of which can be incorporated into the partial schedule under construction without causing infeasibility. Computational experiments using a wide range of standard benchmark problems indicate that the proposed method is fast and very effective.

Application of Artificial Intelligence Approach to Portfolio Selection and Management

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Abstract. This paper is trying to explain the portfolio selection and management problem as a one of the most important problem in finance. Modern portfolio theory and Markowitz efficient frontier start with a set of assets (securities) and generate an optimal weight combination for the optimal risky portfolio that lies on the efficient frontier. The first step is to identify which assets (securities) should be selected from a pool of available assets. The second step is to predict the expected returns for a better utilisation of the Markowitz Efficient Frontier. Artificial Intelligence (AI) techniques are widely used in various fields of finance, which motivated the use of these techniques to find a quantitative and systematic method to construct an optimal portfolio. The Genetic Algorithms Technique (GAs) is one of the AI techniques being successfully used to solve complex optimisation problems. GAs are deployed in this research to select the optimal portfolio based on maximising a composite objective function that maximises return, minimises risk and minimises cross-correlation between assets in the candidate portfolio. GAs are tested on two stock markets, the US stock market, represented by a pool of 40 US companies. In this market the generated optimal portfolio based on Genetic Algorithms was able to provide higher risk adjusted returns than the market index, in both the training period and the testing period. The Neural Networks technique is used to provide a better estimate for expected returns than the conventional historical average. It was found that, even in bearish market periods, the optimally selected portfolio, which was weekly managed using Neural Networks, was able to generate positive returns utilising the Markowitz Efficient Frontier. The research result has demonstrated the usefulness of applying the proposed AI approach represented by Genetic Algorithms and Neural Networks in active portfolio selection and management.

Measuring Equity Similarity by Market Price Sensitivity of Financial Instruments

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Abstract. The paper addresses the problem of classifying a company's financial instruments into equity and debt. We take the perspective of an investor to the company and derive a measure of equity similarity which reflects the risk characteristics associated with financial liability. This approach will allow to assign an equity percentage to every financial instrument by standard valuation methods of finance theory.

Integrating Markdown Policy in Aggregate Production Planning Environment by Developing an APP-MP Model

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Abstract. The high competition in the market of short lifecycle products forces the retailer to use markdown pricing strategy for maximizing the revenue and the manufacturer to develop more appropriate aggregate plan for minimizing the cost. Hence, it is believed that the information sharing and cooperation between them become important now for improving their performance. This paper is to study the significance of the cooperation between the markdown policy and the aggregate planning so as to simulate the cooperation between retailers and manufacturers by a new model, Aggregate Production Planning-Markdown Pricing Model (APP-MP) which is established by integrating the markdown model into Aggregate Production Planning model. The APP-MP is a nonlinear integer programming model which is able to help the retailer and the manufacturer simultaneously make the pricing decisions, including the magnitude and time of markdown, and operational decisions e.g. inventory, outsource etc. so that greater profits could be obtained. The example solution shows that the cooperation definitely increases the profits. Besides, this paper's result also implies that, instead of holding the belief "selling more and earning more", the retailer should cooperate with manufacturer to plan the production by providing demand information to reduce the demand variation. Other insights for markdown pricing strategies are concluded in this study as well.

A Typology of Quality Problems: Lessons from the Automotive Industry

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Abstract. The purpose of this paper is to explore new approaches in the practice of quality management, beyond the existing and well-documented quality approaches of cure and prevention. In-depth case studies at three European automotive manufacturers and their suppliers have shown that a new generation of complicated quality problems has emerged. These problems are neither preventable nor curable at an acceptable cost because their basis is more emotional than technical. It is concluded that traditional expertise in matters technical are no longer sufficient for success. It has become essential to develop skills in the less structured areas of understanding and managing customer relationships.

Class Ranking of the Management Colleges in Taiwan

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Abstract. Evaluation is an effective means for pushing a university to pursue excellence. This paper describes the evaluation of the management colleges of the universities in Taiwan conducted by the Ministry of Education (MOE) of the Republic of China. There are six categories of criteria being considered, viz., faculty, teaching, research, extension services, administration, and general impression. To get an overall picture of the performance, this paper uses a method of class ranking stemmed from the concept of Pareto optimality to stratify the universities into classes of different levels. Universities in the same class are not comparable with each other and are better than those in lower classes. In 2002, 34 universities were evaluated, and thirteen classes were stratified. The results are quite consistent with those ranked by total score. However, in class ranking it is possible that universities with different scores are categorized into the same class and universities with the same score are stratified into different classes. Since the methodology used is essentially the data envelopment analysis without input, the intermediate targets for a university to go through to reach the highest class are obtainable from a dual formulation of the mathematical model.

A Model Investigating the Professional Profile of the HE Graduates: A Case Study of the Electrical Engineers of the TEI WM, Greece

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Abstract. In this study, the Careers Office of the Technological Educational Institute of West Macedonia surveyed the professional and academic situation of Electrical Engineer graduates during the period 1997-1999. The data were collected by qualitative methods using a structured questionnaire with a sample covering 41% of the target population. The main parameter investigated was the current professional situation of the graduates and data concerning their undergraduate and postgraduate studies. The survey concluded that unemployment among electrical engineering graduates is lower compared to other specialities of the TEI. Yet the picture changes, when the graduates' hetero-employment is measured. The relatively good professional situation of the graduates can be partly attributed to the prestigious place in the labour market of older TEI specialities with consolidated professional rights and to the circumstantial development of the construction industry during the years preceding the Olympic Games.

An OR Model for Optimizing Regional Labour Market Policy

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Abstract. A decision aid for optimizing regional labour market policy with a user-friendly computer interface is developed. The distribution of subsidies among 271 German regions is considered as an optimization problem with three targets: (1) equalization of regional unemployment rates, (2) minimization of unemployment, and (3) maximization of GDP, subject to budget constraints and some administrative restrictions. The analysis of a three-year period reveals that the results obtained for 6 Bio EUR could be attained for only 241 Mio EUR (= 4% of the actual budget). Such a bad implementation of active labour market policies can be the cause of their low efficiency often misinterpreted as their uselessness. Among other things, it is shown that tax returns from the additional GDP due to jobs subsidized can transform regional policy into a profitable governmental enterprise.

Numerical Representations of Preferences in Economics

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Abstract. This article is concerned with conditions which imply that the preference relation of the individuals can be represented directly by numerical functions, well-known in economics. These functions, which are central for modelling economic behaviour, are the expenditure function, the distance function, and a Luenberger-type benefit function. Since these functions have an intuitive economic meaning, the preferences of the individuals can be represented in appropriate economic contexts.

Strategic Level Real Options in Corporate Acquisitions

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Abstract. In this paper we present strategic level real options that acquiring companies have in the corporate acquisitions process. The real options presented are such that exist on the strategic level and are different from the real options that reside within the acquisition candidate companies as stand-alone. We present acquisition synergies as real options and strategy level real options created in the acquisition as sequential real options to acquisition timing. Evaluation of target companies that includes the aforementioned real options is discussed.

A Conceptual Model of Supply Chain Governance in Chinese Agribusiness Sector

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Abstract. Chinese agri-food chains consist of the millions of small scale farmers, which are not well structured and organized in the supply chain. Due to market liberalization and globalization, one of the most challenging issues along agri-food chains in China is becoming the issue how to link these small-scale farmers into the modern chains. Consequently it is essential for both policy makers and private sectors to understand the governance structure in agri-food supply chains. Therefore, this paper aims to develop a theoretical framework for supply chain governance, including its antecedents and consequences, as well as a series of hypothesis for empirical test.

Rigorous Affine Lower Bound Functions for Multivariate Polynomials and their Use in Global Optimisation

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Abstract. This paper addresses the problem of finding tight affine lower bound functions for multivariate polynomials, which may be employed when global optimisation problems involving polynomials are solved with a branch and bound method. These bound functions are constructed by using the expansion of the given polynomial into Bernstein polynomials. The coefficients of this expansion over a given box yield a control point structure whose convex hull contains the graph of the given polynomial over the box. We introduce a new method for computing tight affine lower bound functions based on these control points, using a linear least squares approximation of the entire control point structure. This is demonstrated to have superior performance to previous methods based on a linear interpolation of certain specially chosen control points. The problem of how to obtain a verified affine lower bound function in the presence of uncertainty and rounding errors is also considered. Numerical results with error bounds for a series of randomly-generated polynomials are given.

An Optimal Common Set of Weights for Integrated Voting Model

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Abstract. This paper shows the problem of finding the most desirable candidate in a voting system can be integrated into a minimax linear programming model. The paper proposes an optimal common set of weights for the integrated minimax voting LP model. Further it is shown that the integrated model is feasible and capable to rank the most desirable candidate(s).

A First Passage Time Problem in System Replacement

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Abstract. A common replacement policy for technical systems is to replace a system by a new one after its economic lifetime, i.e. at that moment, when its long-run maintenance cost rate is minimal. The strict application of the economic lifetime does not take into account the individual, random deviations of maintenance cost rates from the average cost development. To avoid this disadvantage, Beichelt (2001, 2006) suggested a ‘total maintenance cost limit replacement policy’: A system is replaced as soon as the total maintenance cost spent on it hits a given level. In this contribution, the total maintenance cost development is no longer modeled by functionals of the Brownian motion, but by any stochastic process with nondecreasing sample paths and a convex trend function. Moreover, only the one-dimensional distribution of this process needs to be known. It is proved that with respect to the long-run total maintenance cost rate this policy is superior to the economic lifetime approach. Examples show that applying the total maintenance cost limit replacement policy instead of the economic lifetime leads to cost savings between 4% and 30%. By combining the total maintenance cost limit replacement policy and the well-known ‘age replacement policy’ it is illustrated how the reliability aspect can be included into the model. The simple implementation of the total maintenance cost limit replacement policy, the fact that maintenance cost data are usually available and that no lifetime data are required facilitate its practical application.

Direct Sum Games

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Abstract. The formal mathematical structure of direct sum games is studied, in particular their relation with multiobjective games. A canonical analysis is performed and the notion of equilibrated direct sum games is introduced. For games in the latter class, and even for not too large deviations of them, there is special attention for strictly individually rational full cooperative payoff vectors.

Rough Set Approach to Analyse Sicilian Milk Quality

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Abstract. This paper presents some important basic aspects of the classical Rough Sets approach applied to the values of chemical/microbiological parameters and information about the season and localization of the milk providers. By this approach, we have been able to study the “quality” of the milk in relation to several and inhomogeneous information, such as seasonal trends, place of origin, quantity of proteins, fat, somatic cells and total bacteria found in “high quality” milk samples, produced in a large area in southeast Sicily, during the years 2002-2004. This approach represents a mathematical tool quite different to classical statistics method able also to evaluate the importance of the considered variables. Besides, the results of this study are given in a clear and logical form (i.e. “if... then...” decision rules) which highlight the relation between independent and dependent variables. Examples of such decision rules given by the most relevant condition attributes (independent variables), output of this approach, are represented in some tables, in order to show the most relevant features of the applied methodology. The data, collected every day and provided by a dairy industry, have been processed employing quantitative methodologies. The interesting results obtained with this new method encourage us to develop our research, studying other kinds of milk of different origin and quality.

Implementation of a Traceability System for Food Chains

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Abstract. This paper proposes the results of an exploratory survey, carried out through a suitable questionnaire, elaborated by us, on variables related to the implementation of a traceability system in the citrus fruit sector, one of the most representative of Sicily. In order to have a survey on the problem that is as general as possible, this questionnaire has been proposed to some Sicilian companies of various sizes placed in the provinces of Catania and Syracuse. The target of the analysis is to investigate what are the main company advantages and the critical points found by the different types of companies interviewed. The responses obtained have been elaborated through the Rough Sets approach, a method of data analysis that allows us, through an easily comprehensible language, to describe relations in terms of decisional rules (if...then...), among a series of attributes that describe the different managerial situations of the companies with the critical points found by them regarding the subject discussed. Some examples of such rules are shown in this work as tables in order to point out the interesting results obtained.

Rough Set Analysis for Solid Waste Management and Evaluation

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Abstract. The paper introduces a simple exemplification application concerning four different typical alternatives as regards to the problem of solid urban waste disposal (discharge, incinerator, balanced use of incinerator and composing plant, recycling), concerning the sub-region West Sicily, estimated by means of economic, environmental and technical criteria; with reference to those alternatives, we even know arrangements (global evaluations) expressed by ten different groups (decision makers). We use a useful methodology of decisional support, the Rough Set Analysis; this approach allows to take into consideration quantitative and qualitative data, to stress which are the most important attributes of the performed analysis, and to express results in terms of decisional rules, easily comprehensible and implementable. We speak about some obtained results with underscertainment approach, by stressing methodology and application advantages brought by this approach, useful instruments of success for management of waste and in general for all problems of support to decision in environmental matters.

Water Resources Planning Under Uncertainty Using Simulation Optimization

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Abstract. Water resource policy formulation can prove extremely complicated because most water management systems inherently contain significant stochastic uncertainty. Simulation-optimization (SO) techniques, which incorporate system uncertainties using probability distributions, have recently been used for optimal environmental planning. While SO holds considerable potential for application to a wide range of stochastic problems, its solution search times are stochastic and vary considerably from one implementation to the next. In this paper, techniques are presented to reduce SO search times. In addition, it will be shown that this approach can simultaneously be used to create multiple policy alternatives meeting required system criteria – an approach referred to as modelling-to-generate-alternatives. The efficacy of this environmental MGA approach for policy formulation is illustrated using a water resource management case study. The practicality of this approach can be extended to many other applications in which system components are stochastic, since SO techniques can be adapted to many disparate problems containing significant sources of uncertainty.

Intelligent and Dynamic Detection of Host-Based Anomalies Using Log of System Function Calls

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Abstract. In this paper we propose an approach for automatic detection of intrusions using a log of system's function call. First we preprocess the log to extract proper features. These features are usually discrete and to build our input vector we combine three features and introduce a numeric representation for each possible combination. The combined features are function class and two bits; one represents the difference between real user and effective user and the other is setuid bit of permission flag of each function call. Our numeric representation is the probability of presence of a combination during attacks and a multiplier to reinforce the effect of rare combinations. We use three different dynamic modeling approaches to simulate system calls with the use of Artificial Neural Networks, Locally Linear Neuro-Fuzzy Networks and Hidden Markov Models. We use Sum Rule and Logistic Regression to combine decision. The result shows that in our dataset we identify significant attacks with as low as 0.5% false positive.

Sensor Networks Lifetime Improvement by a Fuzzy Processor

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Abstract. Power dissipation management and hence increasing lifetime in wireless sensor networks (WSNs) is the most critical issue in the design procedure of the modern WSNs. There are many approaches through which power dissipation and lifetime of the WSNs are moderated. In this paper, we present a fuzzy rule based methodology in order to increase the power saving. Consequently, the lifetime improvement in the WSNs will be accomplished. We apply a fuzzy processor to track the best path online for forwarding packets instead of traditional offline table based forwarding process. In addition, this processor is capable of aggregating input data by which the network traffic is extremely reduced. Simulation results show the numerous efficiency of our methodology not only in balancing the power dissipation through network, but also in lifetime improvement, traffic management, and network availability.

Channel Selection in EEG Prediction: Linear and Nonlinear Approach

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Abstract. As being able to predict the epilepsy seizure can directly affect the quality of sufferers' lives, several prediction methods have been developed to improve the accuracy of prediction and to predict seizures long as early as possible before they occur. In this paper, we have shown that fusing the signals of different channels can result in a better prediction. On one hand, it has been discussed that doing a linear analysis (Correlation Analysis) on EEG signals is not competent to describe the relations between channels as predictors. On the other hand, a nonlinear approach (Mutual Information) is used to select the most relevant channels, with the most prediction ability, to the signals of a target channel.

Modifying Brain Emotional Learning Model for Adaptive Prediction of Chaotic Systems with Limited Data Training Samples

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Abstract. In this paper, new method for learning model, based on the brain emotional learning, is explained, which could use to predicate chaotic system which training data is few in. The method is extracted from prior works; but it is changed to improve performance of brain emotional learning in prediction problems. This approach is proposed with high accuracy rather than other brain emotional learning methods and learning systems; in contrast to low computational and memory resources. In addition, this manner has incremental learning property that causes it to be adapted for new stimuli or input. The scope of paper is explained the method and its advantage to raise the accuracy of BEL model in prediction problems. Therefore, the result of the prediction is made by the enhanced model is compared with other methods such as, (MLP) and (ANFIS). Finally, the proposed modified model is examined on the prediction of average price selling of component in trading agent competition. The obtained results verify the good performance of the proposed model with regard to other methods.

Impact of Ubiquitous Computing and Ambient Intelligence on Applied Operational Research

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Abstract. Ambient Intelligence refers to a vision of the future where all of us will be surrounded by intelligent devices and systems that are designed to respond to the perceived needs of the human inhabitants of an environment, trying to predict their needs, forecast possible dangers and hazards, and proactively furnish necessary services or issue timely warnings and provide information or suggestions. It implies a seamless environment of computing and advanced networking technology together with interfaces with the sensors that provide the data about the environments, and actuators that can implement the inferred actions, as well as the intelligent computational and reasoning systems for selecting those actions. It implies a convergence of several technological trends, the most important of which is ubiquitous computing. The latter designates a paradigm shift in information technology where computers embedded in sociotechnical systems and devices become omnipresent, yet virtually invisible in our lives. Advanced human machine interaction routines facilitate the technological enhancement of the environment leading to what has been designated as "Ambient Assisted Living" (AAL). It aims, by the use of intelligent products and the provision of remote services including care services, at extending the autonomy of inhabitants, especially older people and the sick and handicapped; and assisting them in carrying out activities of their daily lives. This vision of the future sets specific demands for the disciplines related to decision making in general, applied operational research in particular. The explication elaborates the author's research endeavors, during the past decade, emphasizing two aspects: computationally intelligent and biomotivated prediction techniques, especially for hazard warning; and emotional decision making mechanisms for provision of autonomous and adaptive control.

Reliability Analysis of Complex Systems with Dependent Elements

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Abstract. A binary coherent system consisting of n elements is considered. Contrary to the usual assumption, the lifetimes of the elements are assumed to be statistically dependent random variables. The dependency between the lifetimes is modelled by their joint probability distribution and by a known copula of their marginal distributions, respectively. It will be investigated which influence a dependency between the failure patterns of the elements has with regard to reliability-theoretic importance measures of the elements. Examples illustrate that the assumption of independently failing elements may considerably distort the true reliability-theoretic importance of an element if there is indeed a dependency between the lifetimes of the elements.

Forecasting Television Waste Flows to Facilitate Sustainability, Industrial Ecology, and Product Take-Back

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Abstract. Industrial ecology is a philosophy that suggests that industrial systems should mimic ecosystems by having all of the outputs from a manufacturing process act as the inputs for subsequent manufacturing processes. Industrial ecology essentially heralds a call for the design of closed-loop systems for production, consumption and disposal, and new legislation is presently driving this concept into both North American and European manufacturing practices. However, this legislation can be significantly confounded by changes to product designs based upon scientific/technological advances and by the introduction of more environmentally benign designs. While waste flows resulting from non-durable consumer goods have been well studied, a lack of understanding surrounding the volumes and timing of waste streams arising from durable products has complicated their potential for inclusion in ecologically-based manufacturing. To illustrate the types of problems encountered in this waste flow modeling, televisions are used to highlight the difficulties surrounding the forecasting and magnitude of the associated uncertainties. The television example proves especially timely due both to the combination of new disposal laws for CRT-based products and to the emergence of alternate technology trajectories. The study illustrates that unless impacted products possess both stable designs and input requirements, then significant secondary environmental issues related to waste storage will arise – which is the case for televisions.

Stochastic Travelling Salesperson Models with Safety Time

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Abstract. We address the stochastic travelling salesperson problem (TSP) with distances measured by travel time. We study how to select the best tour and due date, d , for the minimization of fundamental safe scheduling objectives. In Model 1 the objective is minimizing the due date subject to a service level constraint. In Model 2 the objective reflects a trade-off between the due date and the expected weighted tardiness. Both models involve safety time and therefore the distribution of the tour length is important. We also consider an alternate formulation in which the due date is given. We show that the model 1 alternate is equivalent to model 1 but the model 2 alternate is more complex. We solve for a large subset of parameters, and for other instances, we provide an effective heuristic and performance guarantees.

Stability of Solutions of Linear and Non-Linear Pursuit-Evasion Games with Multiple Goal Sets

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Abstract. The stability of solutions of pursuit-evasion games with multiple goal sets with respect to system parameters and initial conditions are investigated. The notions of the solutions stability with respect to system parameters and initial conditions are extended from the case of a single goal set to the case of multiple goal sets. The solutions' stability with respect to system parameters is investigated when the controlled object's dynamics is described by a system of linear non-stationary differential equations. The case when the dynamic properties of the system are fixed and the case when they change after reaching each goal set are studied. Theorem is proposed and proved which provides sufficient conditions for the stability of the solutions. The stability with respect to perturbations of the initial conditions is studied in the case when the system has constant dynamic properties. The stability of solutions of pursuit-evasion differential games described by non-linear system of ordinary differential equations is investigated in the cases when the system's dynamic properties are constant or piecewise constant. In the case of piecewise constant dynamic properties the system's properties change after reaching each of the multiple goal sets. In the case of systems with constant dynamic properties it is assumed that the sequence of reaching the goal sets is fixed, based on which a single branch is chosen from the family of the u-stable bridges. In the case when the system has piecewise constant dynamic properties, it is assumed that the time moments of reaching the goal sets are also fixed and the branch of the bridge is narrowed. For non-linear systems a piecewise positional strategy extremal to the branch of the u-stable bridge is applied. Theorems are proved which provide sufficient conditions for the stability of the solutions of non-linear systems with constant and piecewise constant dynamic properties.

Application of Ordered Weighted Averaging Operator in Decision-Making

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Abstract. The motive behind of applying the OWA operator for aggregation of decision-making problems is their capability to encompass a range of operators from minimum to maximum including various averaging operators. This paper investigates the steps of applying the OWA operator for aggregation of a decision-making problem.

Author Index

- Amin, G 20, 36
Arab, S 28
Aramyan, L 18
Arsic, V 9
Atoufi, B 29
- Baker, K 34
Beichelt, F 21, 32
Billaut, J 3
Bouboureka, P 14
- Chlingaryan, A 35
Chu, A 5
Chung, W 11
Clasadonte, M 23, 24, 25
Collan, M 17
- Dohn, A 1
- Eldridge, S 12
- Fakhraie, S 28
Fuchs-Seliger, S 16
- Garloff, J 19
Giudice, A 24
Gunalay, Y 26
- Hamzeh, M 28
Horackova, L 5
- Iwaarden, J 12
- Janáček, J 6
Justesen, T 1
- Kalhor, A 29
Kao, C 13
Kergosien, Y 3
Kern, A 10
Khalili, M 7
Kinnunen, J 17
- Larsen, J 1
Lenté, C 3
Lin, P 13
Lucas, C 27, 28, 29, 30, 31
- Matanas, N 14
Matarazzo, A 23, 24, 25
Matarazzo, B 25
Matis, P 4
Mazmanyán, L 34
Moshtaghi, M 27
Mouche, P 22
Moz, M 2
- Naderi, B 7
- Papavasileiou, A 14
Pappalardo, N 23, 24
Parsapoor, M 30
Pato, M 2
- Rasmussen, M 1
- Sheibani, K 8
Smith, A 19
- Tangian, A 15
Tavakkoli-Moghaddam, R 7
Trietsch, D 34
Tsikritzis, L 14
- Walther, U 10
Wiele, T 12
Williams, R 12
- Yeomans, J 26, 33
Yousefi, M 29
- Zhang, X 18
Zhu, W 11

