

WORKING PAPERS 2006

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IE Working Paper 06-001

Data Mining Techniques to Facilitate the Analysis of the Pareto-Optimal Set for Multiple Objective Problems

Heidi A. Taboada and David W. Coit

Abstract:

A method based on a data mining technique is proposed to assist the decision-maker in the analysis of the solutions of multi-objective problems, including system reliability optimization and scheduling problems. Existing methods for solving multiple objective problems involve either the aggregation of all objectives into a single objective, or the determination of Pareto-optimal solutions. These solutions are non-dominated in the sense that it is not possible to improve the value of any objective without simultaneously degrading the quality of one or more of the other objectives. Choosing a solution for system implementation from the Pareto-optimal set can be a difficult task, generally because Pareto-optimal sets can be extremely large or even contain an infinite number of solutions. To illustrate the method, two well-known optimization problems were formulated as multiple objective problems. The proposed method provides the decision-maker a smaller set of optimal tradeoffs: either k different selections or the “knee” cluster.

IE Working Paper 06-002

Multiple Objective Scheduling Problems: Determination of Pruned Pareto Sets

Heidi A. Taboada and David W. Coit

Abstract:

There are often multiple competing objectives for industrial scheduling and production planning problems. Two practical methods are presented to efficiently identify promising solutions from among a Pareto-optimal set for multiple objective scheduling problems. Generally, multi-objective optimization problems can be solved either by combining the objectives into a single objective function using equivalent cost conversions, utility theory, etc., or by determination of a Pareto-optimal set. Pareto-optimal sets or representative sub-sets can be found by using a multi-objective genetic algorithm or by other means. Then, in practice, the decision-maker ultimately has to select one solution from this set for system implementation. However, the Pareto-optimal set is often large and cumbersome, making the post-Pareto analysis phase potentially difficult, especially as the number of objectives increase. Our research involves the post-Pareto analysis phase, and two methods are presented to filter the Pareto-optimal set to determine a subset of promising or desirable solutions. The first method is pruning using non-numerical objective function ranking preferences. The second approach involves pruning by using data clustering. The k -means algorithm is used to find clusters of similar solutions in the Pareto-optimal set. The clustered data allows the decision maker to have just k general solutions to choose from. These methods are general, and they are demonstrated using a multi-objective problem involving the scheduling of the bottleneck operation of a printed wiring board manufacturing line.

IE Working Paper 06-003

A General Column Generation Algorithm Applied to System Reliability Optimization Problems

Leila Zia and David W. Coit

Abstract:

A general column generation approach for system reliability optimization is described and demonstrated. In previous years, a tremendous amount of study has been concentrated on system reliability optimization and column generation as a technique to optimize large-scale problems. This paper can be considered as a continuous and integration of these two topics. It presents new ideas for formulating the allocation problems in reliability systems and opens a new area for application of column generation. We present the reformulation of problems including the redundancy allocation problem, reliability allocation problem and redundancy-reliability allocation problem. Then, we describe how the column generation algorithm can be used to solve these problems. This approach obtains the best-found solutions for example problems while requiring a small fraction of computational efforts required by other methods.

IE Working Paper 06-004

Path-Additive Functions in Stochastic Flow Networks with Markovian Routing

Michael Tortorella

Abstract:

The Jackson network is a basic model favored as a useful beginning approach to many queueing network problems. Its appeal stems from not only its product-form solution for the joint distribution of the number of customers in each queue but also from the simplicity of the structures of the model. Random routing is one such structure. "Random routing" is something of a misnomer because, although the terminology is in common use, the meaning of "random" in this context is exclusively Markovian. The purpose of this paper is to study the ramifications of Markovian routing in a flow network that need not be a Jackson network, principally so that a method can be devised to compute cross-network values of functions whose values on single links are known. The main result is a simple equation for path-additive functions in a flow network in equilibrium (not necessarily a Jackson network) that has random routing. We use this equation to compute latency and jitter in telecommunications packet networks. The class of flow networks we consider includes queueing networks as well as generalizations of flow networks of the type introduced by Ford and Fulkerson.

Informally, a path-additive network function is one whose value on a path is the sum of its values on any partition of the path. For example, the length of a path in a road network is a path-additive phenomenon: the total length traveled along the path is the sum of the individual lengths of the elements of a partition of the path.

IE Working Paper 06-005

An Integrated Analytical Thermal Model for Orthogonal Cutting with Chamfered Tools

Yigit Karpat and Tugrul Ozel

Abstract:

In this study, an analytical slip-line approach is utilized to investigate the friction factor at the tool-chip interface and dead metal zone phenomenon in orthogonal cutting with chamfered tools. Analytical thermal modeling of chamfered tools is also formulated and integrated into the model. Orthogonal cutting of AISI 4340 steel is performed. Measured forces are utilized in identifying the friction factors at the tool-interface. Comparison of predicted and measured forces indicates good agreements. The combined predictive model of forces and temperatures may offer distinct advantages in cutting tool design and process optimization.

IE Working Paper 06-006

Swarm-Intelligent Neural Network System (SINNS) Based Multi-Objective Optimization of Hard Turning

Yigit Karpat and Tugrul Ozel

Abstract:

In this paper, particle swarm optimization, which is a recently developed evolutionary algorithm is used to optimize machining parameters in hard turning processes where multiple conflicting objectives are present. The relationships between machining parameters and the performance measures of interest are obtained by using experimental data and swarm intelligent neural network systems (SINNS). The results showed that particle swarm optimization is an effective method for solving multi-objective optimization problems, and an integrated system of neural networks and swarm intelligence can be used in solving complex machining optimization problems.

IE Working Paper 06-007

On the Integrated Production and Distribution Problem with Bi-directional Flows

L. Lei, H. Zhong and Wanpracha Chaovallitwongse

Abstract:

The integrated production and distribution problem with bi-directional flows is a complicated optimization problem, usually with large problem sizes when encountered in practice. In this study, we propose a partial linear programming (LP) relaxation-based heuristic approach to solve a variation of this problem. The approach is called a *partial relaxation* in the sense that it relaxes the integer requirements only on selected variables. We also report on the gaps between the optimal solution and the heuristic solution provided by this partial relaxation, including analytical gaps for a special case and empirical gaps for randomly generated test cases. Our study on this problem was motivated by the operational planning problem of a medical equipment leasing network that involves a *forward flow* for new and refurbished devices and a *reverse flow* for used devices to be returned to suppliers over a multiple time-period planning horizon.

IE Working Paper 06-008

Path Protection Routing with SRGL Constraints To Support IPTV in WDM Mesh Networks

Meeyoung Cha, Wanpracha Chaovalitwongse, Zihui Ge, Jennifer Yates and Sue Moom

Abstract:

The distribution of broadcast TV across large provider networks has become a highly topical subject as satellite distribution capacity exhausts and competitive pressures increase. In a typical IPTV architecture, broadcast TV is distributed from two sources (for redundancy) to multiple destinations. The aim of this paper is to examine how IPTV can be reliably and cost effectively supported in wavelength division multiplexed (WDM) networks. WDM networks have evolved to mesh topologies and recently to support multicast, which is particularly valuable in reducing the network cost in broadcast TV applications.

Our goal is to find two trees with a minimal total cost such that we have two physically (or Shared Risk Link Group (SRLG)) diverse paths to each of the destinations -- one from each of the sources. Any two links that belong to a common SRLG are subject to a single point of failure, be it a channel or wavelength failure, a fiber cut, or a complete conduit cut. We first show that our path protection routing problem is NP-complete. We then propose an Integer Programming (IP) formulation for this problem. Using real network topology data, we show that the real networks are amenable to the IP problem formulation and yield optimal solutions.

IE Working Paper 06-009

Supporting Internet Protocol TV (IPTCV) in Backbone Networks: Design of Robust Routing Strategies

Meeyoung Cha, Wanpracha Chaovalitwongse, Jennifer Yates,
Aman Shaikh, Zihui Ge and S. Moom

Abstract:

In this paper, we consider the problem of providing IPTV services by designing routing strategies to handle catastrophic failures in a backbone network. In a typical IPTV architecture, broadcast TV is

distributed from two sources to multiple destinations (for resiliency). The aim of this paper is to develop a solution technique for supporting IPTV services in a reliable and cost effective manner. In terms of reliability, any links that go through a common physical route (e.g., fiber, conduit) belong to the same Shared Risk Link Group (SRLG), which is subject to a single point of failure. This paper presents a novel Integer Programming (IP) formulation, in which the objective is to minimize the communication cost such that we have two SRLG-diverse paths from each of the two sources to every destination. In our theoretical study, we demonstrate that a special case of this problem can be solved in polynomial time. The results from our empirical study using real network topologies indicate that the proposed approach can significantly reduce the communication cost compared to the existing heuristic approaches.

IE Working Paper 06-010

A Robust Combinatorial Approach for Sibling Relationships Reconstruction

Wanpracha Chaovalitwongse, T. Y. Berger-Wolf, B. DasGupta and M. V. Ashley

Abstract:

A new combinatorial approach for modeling and reconstructing sibling relationships in a single generation of individuals without parental information is proposed in this paper. Simple genetic constraints on the full-sibling groups, imposed by the Mendelian inheritance rules, are employed to investigate data from codominant DNA markers. To extract the minimum number of biologically consistent sibling groups, the proposed combinatorial approach is employed to formulate this minimization problem as a set-covering problem, which is a well-known NP-hard combinatorial optimization problem. We conducted a simulation study of a relaxed version of the proposed algorithm to demonstrate that our combinatorial approach is reasonably accurate and the exact version of the sibling relationship construction algorithm should be pursued. In addition, the results of this study suggest that the proposed algorithm will pave our way to a new approach in computational population genetics as it does not require any a priori knowledge about allele frequency, population size, mating system, or family size distributions to reconstruct sibling relationships.

IE Working Paper 06-011

Modeling and Simulation of Air Traffic and Changes in the Northern Pacific Airspace: Investigation of Its Effects on system Performance

Theresa Brewer-Dougherty, Brian Colamoca, Elsayed A. Elsayed, Christine Gerhardt-Falk Dale Livingston, Lauren Martin and Christina Schroeffer

Abstract:

This paper presents the details of research with the purpose of investigating the effects of future changes to the North Pacific airspace. This is accomplished through the development of a simulation model, which consists of three distinct modules. Factors such as weather, traffic volume, minimum separation standards, and individual aircraft characteristics are considered in simulating air traffic

crossing the Pacific Oceanic Airspace. Various scenarios reflecting possible future changes are simulated for comparison and results and analysis are presented.

IE Working Paper 06-012

Optimum Threshold Level of Degraded Structures Based on Sensors Data

Elsayed A. Elsayed and Hao Zhang

Abstract:

This paper considers a condition-based predictive maintenance model for degrading systems under continuous monitoring by multiple sensors. Sensors' observations of the degradation criterion are utilized to obtain the optimum threshold degradation level that achieves maximum reliability estimates of the system taking into consideration sensors' errors. The effect of the number of sensors on the accuracy of the reliability estimates is also investigated. A numerical example for a degrading system modeled by a gamma process is presented to demonstrate the use of the proposed maintenance model in practical applications.

IE Working Paper 06-013

Multi-state Component Criticality Analysis for Reliability Improvement in Multi-state Systems

Joe Emmanuel Ramirez-Marquez and David W. Coit

Abstract:

This paper evaluates and implements composite importance measures (CIM) for multi-state systems with multi-state components (MSMC). Importance measures are frequently used as a means to evaluate and rank the impact and criticality of individual components within a system yet they are less often used as a guide to prioritize system reliability improvements. For multi-state systems, previously developed measures sometimes are not appropriate and they do not meet all user needs. This study has two inter-related goals: first, to distinguish between two types of importance measures that can be used for evaluating the criticality of components in MSMC with respect to multi-state system reliability, and second, based on the CIM, to develop a component allocation heuristic to maximize system reliability improvements. The heuristic uses Monte Carlo simulation together with the max-flow min-cut algorithm as a means to compute component CIM. These measures are then transformed into a cost-based composite metric that guides the allocation of redundant elements into the existing system. Experimental results for different system complexities show that these new CIM can effectively estimate the criticality of components with respect to multi-state system reliability. Similarly, these results show that the CIM-based heuristic can be used as a fast and effective technique to guide system reliability improvements.

IE Working Paper 06-014

Collision Risk Modeling in the Northern Pacific Airspace under Separation Reduction and Improvements in Navigational Performance

Theresa Brewer, Brian Colamosca, Elsayed A. Elsayed, Christstine Gerhardt-Falk, Dale Livingston, Lauren Martin and Christina Schroepfer

Abstract:

In this paper, we develop a collision risk model for the Northern Pacific airspace taking into consideration a reduction in separation standards and enhancements in the navigational performance. The well-known Reich collision risk model is modified and extended to consider pairwise interactions between aircraft. Simulation programs are developed and applied to various scenarios, and results including risk estimates are obtained. This study utilizes components of the Northern Pacific Airspace Cost Effectiveness (NPACE) Study, which uses simulated flight data to investigate the effects of future changes to the airspace. The risk assessment of the Northern Pacific airspace shows that by having more flights with RNP-4 designation and supported by careful management of airspace operations to reduce lateral navigational errors, the enhanced navigational accuracy results in lower lateral overlap probabilities, which lead to lower estimated risk in all scenarios. The percent of flights with RNP has a more significant difference of decreased risk within the new track scenarios, which indicates that it is an important factor in future scenarios of reduced lateral separation.

IE Working Paper 06-015

Detecting the Number of Operational Modes in Baseline Multivariate SPC Data

Hang Zhang and Susan L. Albin

Abstract:

When building a multivariate statistical process control model, it is commonly assumed that there is only one operational mode in the baseline data. However, multiple operational modes may exist due, for example, to several suppliers of raw materials or seasonal changes. It is important to know the number of modes in the data in order to construct an effective process control system. Each operational mode appears as a cluster in a baseline data. This paper proposes a new method to identify whether there is one cluster, the most common use, or more than one cluster. If there is more than one, the proposed method identifies the correct number.

Unlike the many existing clustering methods, the proposed method has the following three features that are critical when analyzing baseline data. The proposed method can identify if there is only one cluster, a capability that some existing clustering methods do not have. The proposed method can identify clusters that are convex or non-convex. And finally, the proposed method is insensitive to user-specified parameters.

The paper includes a comparison of the existing and proposed methods on four datasets, which include data from a simulated multiple-zone industrial oven under PID control and data from a real system. The proposed method consistently gives the correct number of clusters while the existing methods do not.

IE Working Paper 06-016

Process Optimization Through Data Mining Eliminates Need for Explicit Quality Function

Il-Gyo Chong, Susan L. Albin and Chi-Hyuck Jun

Abstract:

In process optimization, the setting of process variables is usually determined by estimating a function relating quality and process variables and then optimizing the estimated function. However, it is difficult to build an accurate function from process data in industrial fields because process variables are correlated, outliers are included in the data, and the form of the functional relation between quality and process variables may not be known. A solution derived from an inaccurate function becomes far from the optimal one. To overcome this problem, we use a data mining approach. First, a PLS model is used to reduce the dimensionality of the process and quality variables. Then the process settings that yield the best output are identified by sequentially partitioning the reduced process variable space using a rule induction method. The proposed method finds an optimal setting from historical data without constructing an explicit quality function. The proposed method is illustrated with two examples obtained from steel-making processes. We also show, through simulation, that the proposed method gives more stable results than estimating an explicit function even when the form of the function is known in advance.

IE Working Paper 06-017

On the K-Nearest Dynamic Time Warping Neighbor For Abnormal Brain Activity Classification

W. Art Chaovalitwongse, Wei Zeng and Rajesh C. Sachdeo

Abstract:

Epilepsy is one of the most common brain disorders but the dynamical transitions to neurological dysfunctions of epilepsy are not well understood in current neuroscience research. Uncontrolled epilepsy poses a significant burden to society due to associated healthcare cost to treat and control the unpredictable and spontaneous occurrence of seizures. The objective of this study is to develop and present a novel classification technique used to classify normal and abnormal (epileptic) brain activities through quantitative analyses of electroencephalogram (EEG) recordings. Such technique is based on the integration of sophisticated approaches from data mining and signal processing research (i.e., the chaos theory, the k -nearest neighbor, and the dynamical time warping). The proposed technique can correctly classify normal and abnormal EEGs with up to 95% sensitivity on

average. The experimental results suggest that the proposed technique can be used to develop an abnormal brain activity classification for detecting seizure pre-cursors. Success of this study demonstrates that the proposed technique can excavate hidden patterns/relationships in EEGs and give a greater understanding of brain functions from a system perspective, which will advance current diagnosis and treatment of epilepsy.

IE Working Paper 06-018

Finite Element Analysis of the Influence of Edge Roundness on the Stress and Temperature Fields Induced by High Speed Machining

Tugrul Ozel and Erol Zeren

Abstract:

High speed machining (HSM) may produce parts with substantially higher fatigue strength; increased subsurface micro-hardness and plastic deformation, mostly due to the ploughing of the round cutting tool edge associated with induced stresses, and can have far more superior surface properties than surfaces generated by grinding and polishing. Cutting edge roundness may induce stress and temperature fields on the machined subsurface and influence the finished surface properties as well as tool life. In this paper, a Finite Element Method (FEM) modeling approach with Arbitrary Lagrangian Eulerian (ALE) fully coupled thermal-stress analysis is employed. In order to realistically simulate high speed machining using edge design tools, an FEM model for orthogonal cutting is designed and solution techniques such as adaptive meshing, and explicit dynamics are performed. Work material flow around the round edge-cutting tool is successfully simulated without implementing a chip separation criterion and without the use of a remeshing scheme. FEM simulations for machining-induced stresses by round edge cutting tools are performed for high speed machining of AISI 4340 steel. Once FEM simulations are complete for different edge radii and depth of cuts, the tool is unloaded and stresses are relieved. Stress fields are compared with experimentally measured residual stresses obtained from literature. The results indicate that the round edge design tools influence the stress and temperature fields greatly.

IE Working Paper 06-019

An Experimental and Modeling Study on Meso/Micro End Milling Process

Atul Dhanorker and Tugrul Ozel

Abstract:

In this paper, mechanistic and finite element modeling of meso/micro end milling process with predictions of forces, stresses and temperature distributions in the presence of tool edge ploughing are presented. The finite element modeling of micro end milling without considering tool-workpiece dynamics interaction is introduced to study the effects of cutting conditions on the workpiece deformations in meso/micro end milling. The model is tested and validated for temperature and force predictions in meso/micro end milling of AL 2024-T aluminum.

IE Working Paper 06-020

Reliability Assessment Based on Degradation Modeling With Random or Uncertain Failure Threshold

Peng Wang and David W. Coit

Abstract:

This paper developed extensions to the existing research so that reliability assessment based on degradation modeling can address new problem domains that previously did not meet the required assumptions and modeling constraints. Degradation modeling is based on probabilistic modeling of a failure mechanism degradation path and comparison of a projected distribution to a pre-defined failure threshold. Previous approaches to this problem required that the predefined failure threshold must be considered as a fixed deterministic value, which can be problematic for several reasons. Often, the designer and producer of a part or a system have many diverse users of their products. In practice, the critical threshold value can vary appreciably among users. In this case, a probabilistic, rather than a deterministic threshold value is more appropriate. For other applications, the designer may not know with certainty what explicit level of degradation will cause a failure. In this case, specification of a range of possible threshold values is more appropriate. This also can be accommodated by considering the threshold value as a random variable with some assumed distribution to reflect the variability. New modeling approaches are presented in this paper such that this limiting assumption is no longer required. This should allow systems with more varied usage conditions and failure mechanisms to be analyzed using degradation-based reliability assessment methods.

IE Working Paper 06-021

M/M/C Queues with Markov Modulated Service Processes

Melike Baykal-Gursoy and Zhe Duan

Abstract:

Motivated by the need to study traffic flow affected by incidents we consider M/M/C queueing system where servers operate in a Markovian environment. When a traffic incident happens, either all lanes or part of a lane is closed to the traffic. As such, we model these interruptions either as complete service disruptions where none of the servers work or partial failures where all servers work at some reduced service rate. We analyze the system with multiple failure states in steady and present a scheme to obtain the stationary number of vehicles on a link. The special case of single breakdown case is further analyzed and performance measures in closed form are obtained.

IE Working Paper 06-022

Delay Estimation for Traffic Flow Interrupted by Incidents

Abstract:

Evaluation of the adverse impacts of traffic incidents on a highway network is a critical issue for an incident management program. In this paper, we present a delay estimation method to estimate delays caused by traffic incidents using a recently developed queueing based approach. We validate this method by comparing its results with a simulation model.

IE Working Paper 06-023

Forecasting Using TES Processes

Abdullah S. Karaman and Tayfur Altioek

Abstract:

Forecasting is of prime importance for accuracy in decision-making. For data sets containing high autocorrelations, failure to account for temporal dependence will result in poor forecasting. TES (Transform-Expand-Sample) is a class of stochastic processes to model empirical autocorrelated time series and is frequently used in Monte Carlo simulation. Its merit is to capture simultaneously both the empirical distribution function and the autocorrelation function of a stochastic process. In addition, its analytical background makes it a viable tool to forecast future values of time series data. In this paper, we utilize phase-type random variables as the innovation variable in the TES model fitting methodology. We investigate the forecasting performance of TES processes and compare it to traditional autoregressive integrated moving average models. We find that TES models yield forecasts as accurate as time series models.

IE Working Paper 06-024

Performance Analysis of The Disk Subsystem

Ozlem Akpınar and Tayfur Altioek

Abstract:

An important performance measure in client/server systems is the response time, which is defined as the time elapsed between a request and its associated reply. It is composed of service times, where the actual work is done, as well as waiting times for shared resources. Response time in client/server systems is generally limited by how fast data is retrieved from the underlying storage system. The storage system performance is especially limiting in I/O intensive applications such as OLTP environments, where the response time is of critical concern. Although storage systems have undergone a significant evolution, they are still the bottleneck in information retrieval. Therefore, there is a need to model the performance of disk subsystem in the early stages of its design as well as during its execution, so that a better configuration is achieved. This paper analyzes the performance of disk storage subsystems by obtaining metrics such as response time and throughput. The mechanics of a single disk is studied in great detail. Analytical service time moment equations are derived, and the results are compared against the Disksim* simulation environment. As far as we know, the analytical approach presented is the only one close enough to represent Disksim results. In a typical client/server environment, arrivals to the disk subsystem are departures from the server CPU. Therefore, the Markovian arrival assumption to the disk subsystem, as was made in the early work of [Xiong06] needs to be improved by a more general arrival process. Here, this is done by expressing the interarrival times observed between two disk arrivals mathematically, which then enables us to compute its first and second moments. A phase-type distribution is used to model this general arrival process and to carry out a queueing analysis to compute a set of performance measures. Before implementing the general arrival process with the single disk, the disk is studied with Markovian arrivals. M/G/1 queueing analysis of the system is done, and performance metrics such as the average waiting time at the disk queue, as well as the average number of requests waiting are found. The results are compared against the results obtained from the Disksim. The same analysis is carried out with the general arrival process, which results in a GI/G/1 system. In this step, the results are compared against our simulator, which is fine tuned and statistically proven to represent the Disksim behavior. It is shown that the accuracy of the proposed approximation is highly acceptable.

IE Working Paper 06-025

Performance Analysis of Batch Ordering Policies In Capacitated Supply Chains

Abdullah Karaman and Tayfur Altioek

Abstract:

Devising manufacturing/distribution strategies and determining their parameter values have been challenging problems. Linking production management to stock keeping processes can improve the planning of the supply chain activities, including material management, culminating in improved customer service levels. In this study, we investigate a multi-echelon supply chain that consists of a supplier, a plant, a distribution center and a retailer. Material flow between stages is driven by

reorder point/batch size inventory control policies. The production rate at the plant is finite and transportation times between stages are stochastic. We develop a model to analyze supply chain behavior using some key performance metrics such as the time averages of inventory and backorder levels, as well as customer service levels at each echelon. The model is validated against simulation, yielding good agreement of robust performance metrics, such as average inventory and backorder levels, and customer service levels.

IE Working Paper 06-026

MOEA-DAP: A new Multiple Objective Evolutionary Algorithm for solving Design Allocation Problems

Heidi A. Taboada and David W. Coit

Abstract:

A New multiple objective evolutionary algorithm is proposed for solving system design allocation problems. This new algorithm uses a genetic algorithm (GA) based on rank selection and elitist reinsertion, and a modifying genetic operator constraint handling method. Because GAs are appropriate for high-dimension stochastic problems with many nonlinearities or discontinuities, they are suited for solving reliability design problems. The developed algorithm, MOEA-DAP, mainly differs from other MOEAs in the crossover operation performed and in the parent selection procedure. In the crossover step, several offspring are created through multi-parent recombination. Thus, the mating pool contains a great amount of diversity of solutions. This disruptive nature of our proposed type of crossover, called subsystem rotation crossover (SURC) encourages the exploration of the search space. MOEA-DAP was thoroughly tested and a performance comparison of the proposed algorithm against one of the most successful MOEAs that currently exists shows that our algorithm is more powerful to solve multiobjective redundant design allocation problems.

IE Working Paper 06-027

MOMS-GA: A Multi-objective Multi-state Genetic Algorithm for System Reliability Optimization Design Problems

Heidi A. Taboada, Jose F. Espiritu and David W. Coit

Abstract:

A custom genetic algorithm was developed and implemented to solve multiple objective multi-state reliability optimization design problems. Many real-world engineering design problems are multi-objective in nature, and among those, several of them have various levels of system performance ranging from perfectly functioning to completely failed. This multi-objective genetic algorithm uses the universal moment generating function approach to evaluate the different reliability or availability indices of the system. The components are characterized by having different performance levels, cost, weight and reliability. The solution to the multi-objective multi-state problem is a set of solutions, known as the Pareto-front, from which the analyst may choose one solution for system implementation. Two illustrative examples are presented to show the performance of the algorithm, and the multi-objective formulation considered for both of them, is the maximization of system availability and the minimization of both system cost and weight.

IE Working Paper 06-028

Performance Analysis and Design of Batch Ordering Policies in Capacitated Supply Chains

Abdullah Karaman and Tayfur Altioek

Abstract:

Devising manufacturing/distribution strategies and determining their parameter values have been challenging problems. Linking production management to stock keeping processes improves the planning of the supply chain activities, including material management, culminating in improved customer service levels. In this study, we investigate a multi-echelon supply chain consisting of a supplier, a plant, a distribution center and a retailer. Material flow between stages is driven by reorder point/batch size inventory control policies. The production rate at the plant is finite and transportation times between stages are stochastic. We develop a model to analyze supply chain behavior using some key performance metrics such as the time averages of inventory and backorder levels, as well as customer service levels at each echelon. The model is validated against simulation, yielding good agreement of robust performance metrics. The metrics are then used within an optimization framework to design the supply chain so as to minimize expected total system costs. The outcome of the optimization framework specifies how to move inventory throughout the supply chain and how to set inventory control parameters, i.e., reorder levels and replenishment batch sizes.

IE Working Paper 06-029

Application of Multi-Dimensional Procurement Auction In Single-Period Inventory Models

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Abstract:

Procurement is one of the major activities in the Manufacturing Resource Planning (MRP II), which is closely coupled with inventory management. Any improvement in this area will have a direct impact on the performance of the entire supply chain. Auction mechanism can be a successful procurement method when there are several potential suppliers available. In this work we consider a single-period inventory model when the selection of the supplier being done through a reverse auction with bids consisted of several attributes, namely price, shortage quantity and lead time. The multi-dimensionality of the bid increases the complexity of the underlying problem creating a need for an approach to determine an approximate optimal target level. This is needed for the initiation of the auction and the procurement process. Monte-Carlo simulation method was used to investigate the goodness of the approximate analytical method.

