4

Abstracts

This chapter is divided according to the 17 sections. Inside the sections talks are listed alphabetically according to the name of the speaker.

4.1 Section 1: Revenue Management

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 12a (see p. 49 for session)

Defregger, Florian *(Katholische Universität Eichstätt-Ingolstadt)*

Revenue Management in Manufacturing

Revenue Management has proven successful in service industries like airlines, hotels and car rental companies. Here, the application of revenue management to a manufacturing company is considered. Several markov decision models and a heuristic with numerical results are presented.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12a (see p. 37 for session)

Dörband, Robert *(viavera GmbH, Dortmund)*

Revenue Management in der Gaswirtschaft

Sales departments of gas supply companies and gas traders have access to specialist software for an optimal scheduling of their commodity gas. For gas transmission systems and storage operators there is no similar instrument, which enables them to value the capacity resource based on economic factors. Previous price models are based on a static cost calculation, without taking into account the relative change of capacity value, caused by gas demand changes. The price system of Revenue Management developed in the Airline Industry for evaluation of seat prices allows a variable price arrangement. A transfer of this model into the gas industry for an economic marketing of assets (pipelines and storages) seems to be an advantageous option.

Vertriebsbereiche von Gasversorgungsunternehmen und Erdgashändler verfügen über geeignete Software, welche ihnen im Rahmen der Portfolioanalyse ermöglicht, die Handelsware Gas optimal einzusetzen. Netz- und Speicherbetreibern fehlt dagegen ein vergleichbares Instrument, das ihnen erlaubt die zur Verfügung stehende Ressource unter betriebswirtschaftlichen Aspekten sinnvoll zu vermarkten. Bisherige Preismodelle basieren vorwiegend auf starrer Kostenkalkulation und berücksichtigen daher nicht, die sich durch Nachfrageschwankungen ergebende relative Wertänderung der Kapazität. Das in der Luftfahrbranche entwickelte Preissystem des Revenue Management zur Bewertung der verfügbaren Sitzplatzkapazität ermöglicht eine variable Preisgestaltung. Eine Übertragung des Modells auf den Gasmarkt zur wirtschaftlichen Vermarktung des Assets (Leitungen und Speicher) erscheint vielversprechend.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 12a (see p. 45 for session)

Feller, Jens *(Universität Dortmund)*

Optimal Threshold Policies and an Online Decision Rule for Multidimensional Resources in Revenue Management

Revenue Management deals with selling a limited amount of a perishable resource. This resource becomes valueless at a certain point in time.

In this talk we address the question of an optimal price of these resources in consideration of the remaining time, the resources left and the expected demands. We focus on the characteristics of multidimensional resources which often have to be taken into account, e.g. when transporting freight with limitations to volume and weight or when pricing package holidays as a simultaneous selling of seats and rooms.

We consider this problem as a dynamic stochastic knapsack problem and present a model for maximizing the expected revenue when the distribution functions of the demands and of the offered revenue are known. Further on the model we define conditions of optimal policies. Based on these results we give a threshold policy that can be used for online decision making and discuss different properties of this policy.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 12a (see p. 49 for session)

Fleischmann, Moritz *(School of Management, Erasmus University Rotterdam)*
Hall, Joe *(Tuck School of Business, Dartmouth)*
Pyke, Dave *(Tuck School of Business, Dartmouth)*

Coordinating Inventory and Pricing Decisions when Customers Stockpile

Many modeling approaches have been presented in recent literature that aim to coordinate a company's operations management and pricing decisions. One of the limitations of many of these contributions is a somewhat simplistic demand model that ignores the effects of strategic customer behavior, such as forward buying. Therefore, they may overestimate the benefits of dynamic pricing strategies. On the other hand, richer demand models from the marketing literature typically assume a fairly simple cost structure and thereby overlook operational complexities.

In this contribution, we propose a modeling framework that allows us to explore the interplay between operations and pricing in a more general setting. Specifically, we formulate a discrete dynamic programming model, based on two state variables. The first state variable reflects a company's inventory level. The second one tracks the product volume that is held by the customers. This setup allows us to model dynamic market response to price changes.

We analyze this model to highlight the effect of several supply and demand related factors on appropriate pricing and operating strategies. In particular, we compare dynamic versus fixed pricing policies in different environments. We illustrate our findings with a number of numerical examples.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 12a (see p. 49 for session)

Hellermann, Rolf *(WHU, Otto Beisheim Graduate School of Management, Koblenz)*
Huchzermeier, Arnd *(WHU, Otto Beisheim Graduate School of Management, Koblenz)*
Spinler, Stefan *(Department of Operations and Information Management, The Wharton School)*

Application of Capacity Options for Air Cargo Revenue Management

Capacity allotments are an integral part of the revenue management system of leading air cargo carriers. Being powerful intermediaries, forwarding companies purchase en-bloc capacity in advance at favorable rates, while the airline enjoys a partial transfer of its capacity-utilization risk. Fixed-commitment contracts, sometimes complemented by cancelation policies, are today's industry standard. However, in the light of upcoming dynamic-pricing mechanisms for cargo products, increasing competition, and economic turbulence, the rigidity and pricing of such capacity agreements becomes more and more a problem for the market participants. By modeling the inter-carrier-forwarder market for capacity allotments, we demonstrate how allotment contracts can be formulated as capacity options. The forwarder decides in advance, how many options to purchase and pays a reservation fee r for each option. After observing the demand from her shippers, she decides on the number of options to actually execute against payment of an execution fee e and can purchase additional capacity on the market at the spot price s. We show, under which constellations this form of capacity agreement is welfare enhancing for both buyer and seller and how it fits into current revenue management practices.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12a (see p. 37 for session)

Klein, Robert *(Institut für BWL, Technische Universität Darmstadt)*
Wäscher, Gerhard *(Otto-von-Guericke-Universität Magdeburg)*

Revenue Management und Dynamic Pricing im Rahmen der GOR (Diskussion)

Ursprünglich von Fluggesellschaften entwickelt, repräsentiert das Revenue Management ein Instrument zur Erlösmaximierung in der Dienstleistungsproduktion und wird in Form des Dynamic Pricing verstärkt in der Sachgüterproduktion eingesetzt. Es beruht wesentlich auf dem Einsatz quantitativer Methoden und stellt eines der erfolgreichsten Anwendungsgebiete des Operations Research dar. Entsprechend findet es international erhebliche Beachtung in Forschung und Praxis, so dass nach und nach weitere Einsatzgebiete erschlossen werden.

Während beide Themen im deutschsprachigen Raum zunächst nur in geringem Maße durch die Forschung aufgegriffen wurden, ist in letzter Zeit - wie die aktuelle Tagung zeigt - ein deutlich stärkeres Interesse zu verspüren. Seitens der Praxis ist zu beobachten, dass bisher nur in eingeschränktem Umfang (v.a. im Bereich der Fluggesellschaften) ein Erfahrungsaustausch stattfindet. Es resultiert somit die Frage, wie die GOR sowohl den aktuellen Trend in der Forschung als auch die Kooperation mit der Praxis unterstützen kann. Entsprechende Möglichkeiten sollen mit den an diesem Themenbereich interessierten Tagungsteilnehmern diskutiert werden.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12a (see p. 41 for session)

Lindenmeier, Jörg *(Albert-Ludwigs-Universität Freiburg)*
Tscheulin, Dieter K. *(Albert-Ludwigs-Universität Freiburg)*

The Influence of Revenue Management Techniques on Customer Relations

In times of economic downturn customer relations management has constantly gained importance. Substantial aspects of the customer relationship such as customer satisfaction and retention can be regarded as critical determinants of long-term entrepreneurial success.

In this context an influence of optimal Revenue Management techniques on customer relations cannot be denied. It has to be assumed that e.g. a rejection of passengers as a result of the overbooking of seat inventories can affect customers loyality. An analogous influence can be assumed for induced price intransparencies. Thus it has to be asked whether the positive revenue performance of Revenue Management techniques will be outbalanced by possibly negative effects on the customer relations in the long run.

In a first step customer relationship related constructs will be operationalized and measured based on representative face-to-face-interviews. These constructs include variables like customer satisfaction and retention. Furthermore variables will be considered which are possibly influenced by Revenue Management and which can also be seen as determinants of the customer satisfaction and retention, e. g. perceived quality of specific service characteristics (availability of seat inventories), perceived price fairness or trust in companies using Revenue Management. In a second step assumed causal relations between the mentioned variables will be validated.

The essential goal of this study is the validation of the assumed negative influence of Revenue Management on the customer satisfaction and retention. In addition the differing contributions of the diverse strategic levers of Revenue Management (e.g. the imposition of rate fences or the overbooking of constrained capacities) on the customer satisfaction and retention will be analyzed. Thus starting points for the modification of Revenue Management strategies will be revealed.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 12a (see p. 45 for session)

Meißner, Jörn *(Graduate School of Business, Columbia University, New York)*
Maglaras, Costis *(Graduate School of Business, Columbia University, New York)*

A New Resource Formulation of Multi-Product Revenue Management

We consider a firm that operates a set of resources that are consumed in the process of producing or offering multiple products or services. There is a finite horizon over which these resource must be used. The firm has power to influence the demand for each product by varying its price. Given an initial capacity C for these resources, a selling horizon T, and a multi-product demand function, the firm's problem is to choose a dynamic pricing strategy for each product in order to maximize total expected revenues.

In a multi-product setting, the pricing decisions for each product are linked in two ways: first, the demands for different products may be correlated; and second, different products may be consuming capacity of the same resource. An efficient pricing policy should be able to account for these two effects. In general, revenue management problems are most naturally formulated as dynamic programs, the structural and numerical complexity of which grows significantly as the number of products (the control dimension) and number of resources (the state dimension) increases, respectively. As a result, multi-product problems are addressed so far mostly by solving many decoupled single-product problems.

In this talk we describe a new formulation for multi-product revenue management problems that provides new structural and computational insights. Roughly speaking, we show that rather than formulating such problems in terms of the high-dimensional product pricing strategies, one can instead formulate it in terms of the lower-dimensional aggregate rates at which all products together consume capacity. For the multi-product single-resource problem, this resource formulation is shown to be equivalent to the "traditional" product formulation. Apart from being algorithmically simpler, this formulation also highlights the essential features of good pricing/allocation policies. Finally, this resource formulation is extended to network revenue management problems.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 12a (see p. 45 for session)

Müller-Bungart, Michael *(Technical University Bergakademie Freiberg)*

Network Revenue Management: Some Issues on Upper and Lower Bounds

Extending the well-known revenue management problem with a single resource, a network revenue management (NRM)

problem deals with $m \geq 2$ resources. The most prominent example is a flight network, where an itinerary between an origin and a destination can consist of two or more flight legs.

The most interesting NRM problems arise if demand is uncertain and resource capacity is controlled in a nested manner. In this stochastic scenario the objective is to maximize expected revenue by setting nested booking limits. Unfortunately, the expected revenue function seems to have no closed form, so all known methods for solving this problem optimally are based on dynamic programming (DP) and suffer from high computational cost due to the curse of dimensionality. Therefore, heuristics have been proposed in the literature.

To facilitate the search in the solution space and to assess the quality of heuristic solutions lower and upper bounds would be helpful. To the author's knowledge, bounds on the expected revenue for the NRM problem with stochastic demand and nested capacity have not received much attention yet.

In this presentation, a method to calculate upper and lower bounds on the expected revenue for given booking limits is developed. The bounds are derived by adding up "best case" or "worst case" expected revenues for all possible resource allocations. Therefore the impact of the problem dimension is reduced in comparison to DP.

The method has two main drawbacks: Bounds can only be derived for given booking limits. The method shares this disadvantage with many DP-based procedures, where the expected revenue is calculated only for a given solution, too. In some cases knapsack-like mixed integer programs have to be solved to calculate best/worst case revenues.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12a (see p. 37 for session)

Papadopoulos, Konstantinos *(c/o Kombiverkehr GmbH & Co KG, Frankfurt)*

Herausforderungen für das Ertragsmanagement im kombinierten Güterverkehr

Mit Kombiniertem Verkehr werden Gütertransporte gekennzeichnet, bei denen komplette Ladeeinheiten auf der Strecke von mindestens zwei unterschiedlichen Verkehrsträgern befördert werden. Dem Kombinierten Verkehr wird zukünftig das größte Verlagerungspotential von der Strasse Richtung Schiene zugesprochen. Nach einer kurzen Einführung in die Grundlagen des Kombinierten Verkehrs präsentiert der Autor anhand eines allgemeingültigen Prozessablaufmodells die Transportkette im Kombinierten Verkehr. Es schließt sich die Darstellung des Geschäftsprozessmodells der Kombiverkehr, einem der führenden Schienen-Operateure in Europa, an. Operateure machen sich die Economies of Scale zunutze um effiziente Transportnetzwerke aufzubauen, die sie im eigenen Risiko vermarkten. Ein Überblick über die wichtigsten Produktionskonzepte im Rahmen des Gesamttransportnetzwerkes der Kombiverkehr (Einzelwagen, Ganzzug, Gateway) runden das Bild ab.

Der Transportmarkt ist grundsätzlich ein Markt mit geringen Margen. In der Steuerung des Gesamttransportnetzwerkes kommen daher auch zwingend Methoden des Ertragsmanagements zum Einsatz. Die grundsätzlichen Unterschiede von Güterverkehrs- und Personenverkehrsmärkten macht den Einsatz von Verfahren, die sich in anderen Branchen bewährt haben, schwierig. Der Autor zeigt diese Unterschiede auf und erläutert warum ein Ertragsmanagement im Kombinierten Verkehr in ein übergeordnetes Kapazitätsmanagement integriert sein muß. Es wird dabei herausgearbeitet, dass die meisten Steuerungsinstrumente weit im Vorfeld eines konkreten Transportbedarfs angewendet werden. Eine kurzfristige Ertragssteuerung ist eingeschränkt anwendbar, aber selbst dann ähneln die Instrumente eher einem Kapazitätsallokationsproblem, als einem Preisbestimmungsproblem.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12a (see p. 41 for session)

Petrick, Anita *(Technische Universität Darmstadt)*
Oppitz, Ulrich *(Thomas Cook AG)*

A New Hybrid Method for the Detection of Outliers in an Airline's Booking Data

Most seat inventory control models in airline business require inputs of the expected demand for the optimization process. Airlines use historical booking data extracted from their reservation system to estimate adequate demand information. Thus, the quality of this booking data is crucial to obtain accurate optimization results.

In practice, airlines have to deal with irregular data points so-called outliers. They can, e.g., emerge due to system errors or ad hoc changes in the timetable of an airline. These exceptions do not reflect the typical demand behaviour and can influence the estimation of the expected demand and further steps of the revenue management process substantially. Therefore it is important to identify all outliers.

We investigate a new hybrid method for outlier detection which combines the advantages of two common methods. To evaluate the quality of the algorithm proposed we simulated artificial outliers based on real data from the reservation system of an airline. In comparison to the results of the former methods the hybrid algorithm shows significant improvements in correctly identifying the outliers.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12a (see p. 41 for session)

Riedel, Silvia *(Lufthansa Systems Berlin)*

Adaptive Mechanisms in an O&D Demand Forecasting System

Adaptivity is an important feature for revenue management forecast systems. Due to continuously changing demand caused by seasonality, special events like holidays or trade shows, changes in the flight schedules or changes of the political or cultural situation of a destination, there is a need for robust, adaptive forecasting techniques able to cope with such changes. In this presentation an overview of how such changes are handled in the new forecasting system of the Lufthansa Airline is presented. It describes a general model of adaptation, which is based on abstract terms of attractivness, attractivness changes and short term influences.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12a (see p. 41 for session)

Schön, Cornelia *(Institut für Wirtschaftstheorie und Operations Research, Universität Karlsruhe)*

Service Pricing & Revenue Management: An Integrated Approach of Marketing and Operations

Pricing services most profitably is often a complex task. Almost all service providers face some sort of capacity constraints, when demand peaks, as capacity often cannot be adjusted in the short run. Hotels for example have only a limited number of rooms, telecommunication service providers are restricted by network bandwidth, airlines can only offer a constrained number of seats per flight. Furthermore, with time elapsing, unused capacity is lost forever, known as the problem of perishability. Moreover, customers are heterogeneous with respect to price- and time-sensitivity and demand can often be only forecasted with uncertainty. Finally, as an external factor, the customer himself plays an important role in the service delivery process.

Given these characteristics, the basic objective of revenue management is to allocate fixed capacity to match the potential demand in various market segments most profitably. It usually employs multi-period dynamic pricing models involving discounts for early reservations and reserving some capacity for later sales at a higher price. Thus, revenue management establishes an important interface of operations and marketing problems.

Marketing literature on the other hand offers a multiplicity of interesting approaches especially applicable to the problem of pricing services, integrating sophisticated models of customer behaviour. Some excellent examples of these approaches are bundle pricing – commonly employed e.g. in the package holidays business; non-linear pricing – as in the case of Deutsche Bahn's "Bahn Card"; product-line pricing – important for almost every provider offering differentiated services. Furthermore, economics and pricing literature offers the peak-load pricing approach to most profitably differentiate prices across time periods.

We will discuss these different approaches with respect to the problem of pricing services, point out what they can learn from each other and motivate the need to better integrate marketing and operations. We present an integrated (marketing- and operations-oriented) approach for pricing services that takes the factors mentioned above into account (fixed capacity, perishability, heterogeneous customer behaviour). Furthermore, we want to point out important areas for future work.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12a (see p. 37 for session)

Thiel, Rüdiger *(Lufthansa Systems Berlin)*

Low Cost Carrier - ein neues Feld für Revenue Management

Als die großen amerikanischen Airlines Anfang der 80ziger Jahre Konkurrenz von kleineren und billigeren Airlines bekamen, war dies die Geburtsstunde des Revenue Management für Airlines. Damit haben sich die großen Airlines ihren Marktanteil zurückerobert. Die großen Airlines hatten ihre Reservierungsdaten über Jahre gesammelt. Dadurch waren sie in der Lage, mit statistischen Methoden Analysen durchzuführen. Kunden- und Flugdaten wurden segmentiert und Prognose- und Optimierungsverfahren entwickelt, zwei Grundelemente eines erfolgreichen Revenue Management Systems.

Seit einiger Zeit machen nun Low Cost Carrier mit Erfolg den traditionellen Airlines Konkurrenz. Heute ist das Wissen über Revenue Management Methoden sehr reichhaltig. Im traditionellen Airline Geschäft wird mit Hilfe von Verfügbarkeit von Produkten der Ertrag maximiert. Im Low Cost Carrier Geschäft wird immer nur ein Produkt zu einem Zeitpunkt angeboten. Zu einem späteren Zeitpunkt wird das gleiche Produkt teurer verkauft. Obwohl diese Geschäftsgrundideen unterschiedlich sind, wird untersucht, ob durch eine Modifikation eines alten Modells (Preis-Elastizitäts-Modell) Ertragsmaximierung auf Low Cost Carrier übertragbar ist. Die Gegenüberstellung mit einem zweiten Ansatz (z.B. ein regelbasiertes Verfahren) rundet die Betrachtung Revenue Management für Low Cost Carrier ab.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 12a (see p. 49 for session)

Thonemann, Ulrich *(University of Münster)*
Zhu, Kaijie *(Hong Kong University of Science and Technology)*

Coordination of Pricing and Inventory Control Across Products

We consider the joint pricing and inventory-control problem for a retailer who orders, stocks, and sells two products. Cross-price effects exist between the two products, which means that the demand of each product depends on the prices of both products. We derive the optimal pricing and inventory-control policy and show that this policy differs from the base-stock list-price policy, which is optimal for the one-product problem. We show that the retailer can improve profits significantly if the retailer takes the cross-price effects into account and manages the two products jointly. We also present structural results of the optimal pricing and inventory-control policy, such as the submodularity of the expected profit in the inventory levels, and discuss some extensions of the model, such as its adaptation to managing complementary products.

4.2 Section 2: Telecommunication and Information Technology

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1017 (see p. 41 for session)

Bley, Andreas *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*

A Lagrangian Approach for Integrated Network Configuration and Routing Planning in IP Networks

We consider the problem of designing a network that employs a non-bifurcated shortest path routing protocol, such as OSPF or IS-IS.

Given the nodes, forecasted traffic demands, all potential links, and all relevant hardware components, the goal is to simultaneously decide the network's topology, its link and node hardware configuration, and the routing weights, such that the overall network cost is minimized.

We present a mathematical optimization model and a Lagrangian relaxation based approach to solve this problem and report on computational results for several real-world network planning problems.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 37 for session)

Eisenblätter, Andreas *(atesio GmbH, Berlin)*
Fügenschuh, Armin *(Technical University Darmstadt)*
Geerdes, Hans-Florian *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Junglas, Daniel *(Technical University Darmstadt)*
Koch, Thorsten *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Martin, Alexander *(Technical University Darmstadt)*

Models for UMTS Radio Network Planning

UMTS, the Universal Mobile Telecommunications System, is a 3rd generation cellular system for mobile telecommunication. UMTS supports all services known from GSM and GPRS, but it is more powerful, more flexible, and more radio spectrum efficient than its predecessors. Radio transmissions are not separated in time or frequency. Instead, they are superimposed in time and frequency, separable only by means of their encoding (wide-band code devision multiple access, W-CDMA). For a proper decoding, a minimum ratio, called CIR, between the carrier's strength at the receiver and the interference has to be achieved. As a consequence, the cells' capacity and coverage are strongly inversely coupled through system self-interference, and the network's capability to serve users' demand depends on the transmission powers required to satisfy all CIR requirements.

The typical network planning process cycles in a time consuming trial-and-error fashion through tentative network designs and simulation-based network performance analysis. An automatic search for a low-cost network design, achieving the required quality standard is therefore in high demand.

In this presentation, we introduce the context of the planning process: service and source models, spatial load distributions, and hardware characteristics are explained. We model designing a radio network with a mixed integer program, whose scope is to select base station locations (from a list) and to configure base stations, including antenna types, heights, azimuths, and tilts as well as the cell's dominance areas. Several solution methods and examples of network designs for a real-world planning scenario from downtown Berlin are presented in a companion talk by Daniel Junglas.

This work has been carried out in the EU-funded project MOMENTUM (http://momentum.zib.de).

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 37 for session)

Fledderus, Erik R. *(TNO Telecom / Eindhoven University of Technology)*

Snapshots for Planning and Evaluation of Cellular Networks

The use of snapshots (realisations of a stochastic demand) to evaluate and plan cellular networks has been standard for second-generation CDMA networks. But how well does the method behave when other services then voice are considered? We will discuss recent advances in snapshot selection in the field of UMTS radio network evaluation and its application to optimal network design.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1017 (see p. 41 for session)

Hoesel, Stan van *(University Maastricht)*
Kraaij, Anton van der *(University Maastricht)*
Bouhtou, Mustapha *(France Telecom)*
Mannino, Carlo *(Universita La Sapienza Roma)*
Oriolo, Gian Paolo *(Universita Tor Vergata Roma)*

Tarification of Connections in Telecom Networks

We consider the problem of determining a set of optimal tariffs for an operator, who owns a subset of the arcs of a telecommunications network, and who wishes to maximize his revenues. In the network multiple rational clients are active, who route their demands on the cheapest paths from source to destination. The cost of a path is determined by fixed costs and tariffs on the arcs of the path.

We develop a shortest path graph model that is equivalent to the tarification problem. This model allows computationally efficient solution methods, when used in combination with (pre)processing ideas. The shortest path graph model is also useful for obtaining theoretical results, such as the identification of polynomially solvable cases of the tarification problem. Specifically, we will show that the problem with a fixed number of tariff arcs in the network can be solved in polynomial time. We will also discuss complexity and approximability of the problem.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 37 for session)

Junglas, Daniel *(Technische Universität Darmstadt - Fachbereich Mathmetik)*
Martin, Alexander *(Technische Universität Darmstadt - Fachbereich Mathematik)*
Fügenschuh, Armin *(Technische Universität Darmstadt - Fachbereich Mathematik)*
Eisenblätter, Andreas *(Konrad-Zuse-Zentrum für Informationstechnik, Berlin)*
Geerdes, Hans-Florian *(Konrad-Zuse-Zentrum für Informationstechnik, Berlin)*
Koch, Thorsten *(Konrad-Zuse-Zentrum für Informationstechnik, Berlin)*

Optimization Methods for UMTS Radio Network Planning

The Universal Mobile Telecommunications System (UMTS) is a 3rd generation cellular system for mobile telecommunications. The planning of UMTS networks is a challenging problem. One key issue is to select base station locations and to configure base stations including antenna types, heights, azimuths, and tilts such that the required services are met. The problem leads to a huge mixed integer program the modelling of which has been discussed in the preceding presentations by Roland Wessäly and Andreas Eisenblätter. In this talk we deal with solution methods of this model. We demonstrate success and limits of general MIP solvers, we present model reformulations including valid and heuristic inequalities, and we discuss primal meta-heuristics. Computational results on realistic data conclude the presentation.

This work has been carried out in the EU-funded project MOMENTUM (`http://momentum.zib.de`).

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1017 (see p. 41 for session)

Popova, Olga *(Omsk State Technical University)*

Optimization of the Economical Decisions on the Basis of Reflexive Information Technology – VINTSELLING

Information technology of the decision making in the trading activity is under consideration. New author's method named "Virtual Information Technology for Selling - VINTSELLING" have been proposed. It is founded on the reflextion model of consumer choice. The reflexive method proposes two aspects of the logic for the decision maker.

The situational personal logic is characterized by a situational function of realistic choice. Reflexive logic can be expressed by "the Lefebvre's formula of the person". The technology generates some special system of tools, which one allows to engineer a screen of a customer, screen of the seller from a stand with choice of preferences and decision marking.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 37 for session)

Ziegelmann, Mark *(Siemens AG, München)*
Lauther, Ulrich *(Siemens AG, München)*
Winter, Thomas *(Siemens AG, Berlin)*

Optimization for UMTS Radio Access Network Planning

Network optimization strategies form an important part in radio access network planning approaches for second and third generation mobile systems like GSM and UMTS.

We have developed a powerful optimization tool that allows fast and reliable automatic planning of the UMTS radio access network. The network design step decomposes into the following planning and optimization steps:

1. Clustering of base stations into areas and placement of a so-called radio network controller (RNC) within these clusters.
2. Inter-connection the RNC and connecting them to the backbone network.
3. Network topology optimization withing the clusters.

We developed efficient optimization algorithms for these problems aiming to minimize the total cost for setting up and running the network (costs are traffic and length dependent link costs and traffic dependent device costs).

Additionally, our tool offers phase planning, planning based on existing (GSM) infrastructure and user interactive planning.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1017 (see p. 41 for session)

Zymolka, Adrian *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Koster, Arie M.C.A. *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*

Wavelength Assignment with Converters in All-Optical Networks

In optical telecommunication networks, Wavelength Division Multiplexing (WDM) allows for the efficient usage of fibers by transmitting optical signals in parallel on different wavelengths. In addition, Optical Cross Connects provide full optical switching in the nodes. This enables to establish connections as ongoing optical channels across several links, so-called lightpaths. A lightpath is a path together with a wavelength associated to each of its links. At the nodes, a lightpath can exchange the wavelength of operation at the cost of a wavelength converter. For a given lightpath routing satisfying all capacities in the network, the wavelength assignment problem consists in the conflict-free allocation of the available wavelengths to the lightpaths with a minimum number of converters.

In this talk, we investigate this generalized coloring problem and its relation with both vertex and edge coloring. We present integer programming formulations for the minimum converter wavelength assignment problem and discuss their properties. For the most promising formulation, we derive a column generation algorithm to obtain good assignments.

4.3 Section 3: Production, Logistics and Supply Chain Management

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 04 (see p. 45 for session)

Behrens, Sven *(Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum)*

Effizienzuntersuchungen in Losgrößenmodellen

Losgrößenmodelle werden sowohl in der Bereitstellungsplanung als auch in der Prozessplanung verwendet. Ihr Einsatz zeigt, dass im Produktionsmanagement auch unter kundenorientierten Strukturen neben der Auftragsgröße des jeweiligen Kunden Aufwandsziele relevant bleiben. Aufwand in Abhängigkeit von der Losgröße entsteht aber zum einen bei der Bestellung bzw. bei der Umrüstung der Anlage, zum anderen bei der Zwischenlagerung von Gütern, die nicht oder noch nicht abgerufen werden. Üblicherweise werden beide Aufwandsgrößen mit Opportunitätskostensätzen bewertet

und so optimale Losgrößen bestimmt. Diese Bewertung enthält wie jede Bewertung in der Betriebswirtschaftslehre eine gewisse Willkür. Ändert sich der Kalkulationszins oder der Wertansatz für die Zwischenprodukte oder werden Rüstkosten neu kalkuliert, so ändert sich auch die optimale Losgröße. Problematisch sind Opportunitätskostenansätze auch in mehrstufigen integrierten Planungsmodellen, vgl. Drexl / Haase / Kimms, 1995. In diesem Beitrag wird die Frage untersucht, welche Aussagen man über die zielkonforme Wahl von Losgrößen bereits vor der Bewertung treffen kann. Das wichtigste Hilfsmittel ist dabei der produktionstheoretische Effizienzbegriff. Dessen Anwendung führt zur Bestätigung und damit zur theoretischen Fundierung bekannten Praktikerwissens. Viele "klassische" oder "goldene Regeln" lassen sich in der Tat auf Effizienzargumente zurückführen. Daneben kann durch die hier vorgelegte produktionstheoretische Fundierung noch ein zweiter Beitrag geleistet werden. In mehrstufigen Losgrößenmodellen mit unterschiedlichen Entscheidungsträgern auf den einzelnen Stufen kann neben der Ermittlung von Effizienzmengen aus übergeordneter Perspektive auch die Bestimmung von Effizienzmengen aus Partialsicht vorgenommen werden. Damit lassen sich Interessenkonflikte zwischen den Partnern einer Supply Chain theoretisch begründen.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 04 (see p. 41 for session)

Bilgen, Bilge *(Department of Industrial Engineering, Dokuz Eylul University, Izmir)*
Ozkarahan, Irem *(Department of Industrial Engineering, Dokuz Eylul University, Izmir)*

Mixed Integer Programming (MIP) Approach for Distribution System Planning Problem

The design of distribution system is an important issue in many organizations, since distribution cost makes a significant contribution to total cost. Distribution system consists of a set of customers that are served by a fleet of vehicles. In this paper we consider multi-period, multi-type product distribution planning system where a fleet of heterogeneous tankers deliver various types of products from ports to the customers. In this research, the problem is formulated as mixed integer linear program (MILP). Given a set of potential ports and customer sites, the problem is to determine which customers to deliver from which ports, and how many and what type (size) of tankers to use for delivery. It is a deterministic formulation that considers minimization of total cost that includes transportation cost for each tanker, loading cost at ports, and blending cost. Within the constraints, the model considers customer demand constraints, supply constraints, blending constraints, capacity constraints for each tanker, and loading constraints at ports. The main contribution of this paper is that, it is a real case problem and considers tactical issues such as blending process as well. Besides this, related literature is reviewed and the place of the developed model is displayed within the literature. We also provide table of main characteristics of the reviewed models to help summarize the research that has been done in the distribution planning area.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 05 (see p. 56 for session)

Bock, Stefan *(University of Paderborn)*

Real-Time Control of Transportation Network

Due to the liberalization and deregulation of the transport market in the European Union, truckage companies in middle and west Europe are facing a significantly intensified competition today. Therefore, these companies have to increase the efficiency of their transport processes. To do so, especially companies of moderate size try to cooperate which leads to additional instruments such as hubs or the use of external services. For an efficient execution of the transport processes it becomes more and more important to decide about the use of these instruments in a very short term, depending on the current situation in the controlled transportation network. In addition to this, the increasing availability of real-time information in transportation networks leads to further requirements for a modern control of logistical processes. Therefore in this work a new approach is considered that realizes a real-time control of transportation processes. As a main attribute this control continuously improves the transportation plan that is already in execution with respect to all decisions that are not already taken. This leads to a situation where an improvement process for adapting the plan that is currently in execution with respect to the given situation is always active. To enable a very adaptable reaction of the control on possible disturbances in the transportation network the transport-chains in a computed solution can be defined in a very flexible way. For this, for example an arbitrary number of transshipment operations can be integrated in every transport-chain of a transfer order as well as the use of hubs and external services. In addition to this, there is no restriction for the definition of transport-chains of orders already picked-up. As possible disturbance scenarios breakdowns or decelerations of vehicles and routes are considered. The efficiency of the designed real-time control has been validated by several test scenarios.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 04 (see p. 49 for session)

Bong, Cheng-Siong *(Multimedia University, Selangor)*
Omar, Mohamed Khaled *(Multimedia University, Selangor)*

Production Planning under Dynamic Environment: An Integrated Framework Approach

Production planning in the semiconductor industry is a complicated task that requires cooperation among multiple

functional units. In order to design an efficient production planning system, a good understanding of the environment in terms of customers, product and manufacturing process is a must. It is true that such planning exists in the company, it is often incorrectly structure in terms of the presence of multiple conflicting objectives.

This paper reports on an attempt to develop a hierarchical framework, which comprises of two level hierarchy decision structure for semiconductor manufacturing firm.

The proposed hierarchical production-planning framework is comprised of aggregate and disaggregate module. The aggregate-planning module was formulated as an integer linear programming model, provides aggregate production, workforce, and inventory levels. A weighted integer goal-programming model is developed for the disaggregate planning module to provide a master production schedule that determine production schedule for individual product.

This paper is concerned with presenting project research theme statement, framework structure, and problem formulation.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 05 (see p. 53 for session)

Buscher, Udo *(Faculty of Economics and Management, University Würzburg)*
Lindner, Gerd *(Faculty of Economics and Management, Otto-von-Guericke Universität Magdeburg)*

An Economic Production Quantity-Model for a Multi-Stage Production System with Defective Items and Rework

For manufacturing purposes most often very sophisticated equipment is used. Nevertheless, some defective units occur even in production systems comprised of high quality facilities. Frequently, there is an economical incentive to rework defective products into an "as new condition because they incorporate substantial values. Since in practice production and remanufacturing activities often take place on common facilities, one has to coordinate the timing of operations as well as to determine appropriate lot sizes for both processes. Another aspect concerns the issue that a decision has to be made on how to transport units fabricated at a particular stage to the next activity. Most lot-sizing models restrict the number of shipments between stages to only two settings. Either entire lots are conveyed or each item is transported immediately after its completion. It seems to be more realistic also to allow transports of partial lots — called batches — larger than one and smaller than the entire lot, as well. Moreover, nearly all approaches for joint planning of production and rework lot sizes analyze only single-stage environments. In contrast to them, an approach focusing on a serial multi-stage production/recovery system will be presented in this paper. At each stage a uniform production lot size is fabricated. Due to an imperfect underlying process, this quantity contains only a certain fraction of good quality items. The other portion are defectives which will be reworked in one lot immediately after production stops. Good quality units may be transported in equal-sized batches to the succeeding activity before production and rework are finished at the preceding stage. Thereby, the number of batches is allowed to differ across stages. Considering setup, inventory holding, and transportation costs a method is developed for determining appropriate lot and batch sizes.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 05 (see p. 56 for session)

Dörner, Karl *(Universität Wien)*
Reeh, Michael *(Universität Wien)*
Strauß, Christine *(Universität Wien)*
Wäscher, Gerhard *(Otto-von-Guericke-Universität Magdeburg)*

Artikelanordnung bei Mann-zur-Ware-Kommissionierung

Das Kommissionieren stellt eine Lagerhausfunktion dar, bei der Kundenaufträge durch Entnahme gelagerter Artikel aus ihren Stellplätzen im Lager zu erfüllen sind. Mann-zur-Ware-Kommissioniersysteme verfügen typischerweise über in parallelen Gängen angeordnete Stellplätze, von denen das Kommissionierpersonal die durch Kommissionieraufträge vorgegebenen Waren entnimmt. Kommissioniervorgänge in solchen Systemen zählen zu den kostenintensivsten Lagerhausprozessen – sie betragen bis zu zwei Drittel aller im Lager anfallenden Kosten und stellen in der Praxis erhebliches Einsparungspotential dar. Grundsätzlich lassen sich drei Bereiche identifizieren, in denen sich Kostenreduktionen erzielen lassen: (1) Zusammenfassung mehrerer Kundenaufträge zu Kommissioniertouren (Batching), (2) Bestimmung eines Kommissionierwegs durch das Lager (Routing) und (3) Artikelanordnung in Abhängigkeit von Artikelzugriffshäufigkeiten und -volumen (Storage). Zwischen diesen drei Problemkreisen bestehen starke Interdependenzen; so läßt sich beispielsweise durch eine verbesserte Artikelanordnung unter Berücksichtigung der gewählten Routingstrategie die vom Kommissionierpersonal zurückzulegenden Wege und damit die entsprechenden Kommissionierzeiten und -kosten erheblich reduzieren.

In diesem Vortrag werden die Ergebnisse numerischer Experimente präsentiert, bei der die Eignung von drei unterschiedlichen Anordnungsstrategien unter Berücksichtigung verschieden ausgeprägter Artikelzugriffshäufigkeiten, variierter Gassenanzahl und zwei verschiedenen Routingstrategien (Largest Gap, S-Shape) untersucht wurden. Als weitere Einflußgrößen wurde die verwendete Batchingstrategie, das Fassungsvermögen des Kommissioniergeräts, der Auslastungsgrad des Lagers und die Größe der Kundenaufträge als Problemparameter berücksichtigt.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 05 (see p. 49 for session)

Elhafsi, Mohsen *(University of California, Berkeley)*
Elimam, Abdelghani *(San Francisco State University)*
Dodin, Bajis *(University of California, Berkeley)*

Assignment and Dynamic Loading of Chemical Products to Bulk Tankers

This paper deals with the problem of shipping liquid chemicals using oceangoing vessels. More specifically, it deals with the problem of assigning liquid chemicals and pumps to ship compartments and then determining the optimal pumping schedule of the assigned chemicals into the ship compartments. The problem is handled in a hierarchical manner; the assignment problem is formulated and solved as a mixed integer program while the pumping schedule is first formulated as a two-point boundary-value optimal control problem, and then solved using newly developed heuristics. Computational experiments show that this treatment of the problem captures the many real world considerations and can be used to model and optimize the operation of large oceangoing vessels.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 04 (see p. 49 for session)

Faißt, Bernd *(University of Karlsruhe)*
Furmans, Kai *(University of Karlsruhe)*

The Impact of the Exchange of Market and Stock Information on the Bullwhip Effect in Supply Chains

Within supply chains the participating companies usually are managing their inventory independently from upstream or downstream companies. Locally oriented inventory policies and insufficient information exchange inevitably lead to sub-optimal performance for the whole supply chain. An advantage of a cooperative contractual relationship within a supply chain is to avoid inefficient inventory control policies, which result from a lack of co-operation due to uncertain future demand rates and inaccurate information. The companies can exploit this potential only if they are willing to coordinate their control policies with the other companies in the supply chain. Starting from an isolated company we introduce a storage control model, which will be used for the subsequent steps. The calculation of the optimal order quantity is done by discrete markovian decision models. In the next section of this paper we analyze the reasons of the bullwhip effect. We focus on the lack of information exchange in an environment with stochastic market demand. This leads to over-reactions in the calculations of the demand forecast in the companies with a great distance to the market. We can show mathematically, that under the assumption of stochastic market demands the variances of the orders of a participating company is bigger than the variances of the arriving demands. Thus the existence of the bullwhip-effect within a multi-stage supply chain is verified. The impact increases with the distance of the specific company from the market. We enhance the basic model of the supply chain by an information exchange system in order to enhance the basis of information to calculate the order quantities. It can be shown that the value of the amplification of variances of the amount of orders is decreased on every stage of the supply chain. This effect is more distinct on stages of the supply chain with a big distance from the market.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 05 (see p. 41 for session)

Gotzel, Christian *(Otto-von-Guericke-Universität Magdeburg)*
Inderfurth, Karl *(Otto-von-Guericke-Universität Magdeburg)*

Policy Approximation for the Production Inventory Problem with Stochastic Demand, Stochastic Yield and Production Leadtime

We consider a single-stage production inventory problem with stochastic demand and stochastically proportional yield. Holding, penalty and ordering costs are assumed to be linear. For the case of uniformly distributed demand and yield, the optimal ordering policy in the single period case is analysed. Furthermore, heuristic policies are compared in a numerical study over an infinite horizon. Our results show that a MRP-based heuristic provides a good approximation for this problem. As an extension, the issue of adding a remanufacturing option is addressed.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 04 (see p. 53 for session)

Habenicht, Ilka *(Institut für Wirtschaftsinformatik, Technische Universität Ilmenau)*

Scheduling Jobs with Reentrant Flows Using Lagrangian Relaxation Techniques

In this paper, an algorithm for scheduling jobs with reentrant flows is proposed. Aggregated capacity restrictions are considered based on parallel machines. The complex scheduling problem is decomposed into several, more tracktable, subproblems for individual parts by using Lagrangian relaxation. Each subproblem can be reformulated into a network flow problem. The arcs of the resulting networks represent costs for waiting and processing a single operation and can

be calculated based on Lagrange multipliers. The subproblems can now be solved using methods for minimum cost flow problems. A subgradient method for updating Lagrange multipliers is decribed. An efficient repairing heuristic is developed to obtain feasible schedules from subproblem solutions. The convergence behavior of the scheduling algorithm is improved by integrating the repair heuristic into the subgradient algorithm. A set of experiments is performed in order to carry out the necessary parameter settings. We will present numerical results in the last part of the talk.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 05 (see p. 37 for session)

Hoberg, Kai *(Institute of Supply Chain Managment, Münster University)*
Thonemann, Ulrich *(Institute of Supply Chain Managment, Münster University)*

Analyzing the Behavior of Supply Chains in Response to Stationary and Non-Stationary Demand: A Control Theoretic Approach

Most inventory research focuses on minimizing inventory holding, backorder, and ordering costs when demand is stationary. Rarely has the research addressed the dynamic demand setting and performance measures that are relevant in that setting, e.g., the variance of inventory, production quantities and order quantities in response to dynamically changing demand. However, high variance in a production schedule, for example, requires either a large capacity or costly adjustment of the capacity level. In a dynamic demand setting, inventory policies must be sensitive to changes in demand but should not overreact. In this paper, we analyze the dynamic behavior of various inventory policies from a control theoretic perspective. We consider three categories of inventory policies that focus on inventory-on-hand, installation stock and echelon stock. Policies that focus purely on inventory-on-hand and ignore orders in the pipeline are simple and still common in practice. However, we prove that these policies are unstable under practical conditions. Therefore, we focus on the comparison of installation stock and echelon stock policies in a two-echelon supply chain and derive their transfer functions. For each policy category we present two different policy types the original order-up-to policy and a policy that is partially adjusted according to the error between the target installation or echelon stock and the actual level. To analyze the performance of the policies we introduce performance measures for stationary and non-stationary demand. We use these measures to investigate the effects of the policies on order amplification along the supply chain and the oscillation of inventory. Finally we introduce information delay to the two-echelon supply chain and analyze its effect on the echelon stock policies and performance. We show that even in the presence of information delay the echelon stock policy with partial adjustment shows superior behavior.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 05 (see p. 37 for session)

Jodlbauer, Herbert *(FH-Steyr)*
Althaler, Joachim *(FH-Steyr)*

The Influence of Inventory Deviation on Lead-Time and Utilization

It is widely known that lead-time and utilization are dependent on work in progress (WIP). This article validates the functional relationship between inventory deviation and lead-time by means of simulation. In addition, the results confirm a new mathematical model for the logistic operating curves in practice. A new approach is based on the idea that changing a machine from overload to underload and vice versa results in a waste of utilization and therefore in an increase in lead-times. The frequency of the changes from under- to overload and vice versa which determines this waste, is measurable by means of the statistical deviation of the inventory.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 05 (see p. 41 for session)

Kiesmüller, Gudrun *(Technical University Eindhoven)*

Coordinated Transportation and Inventory Management in Supply Chains

In order to lower transportation costs in supply chains consolidation policies can be used to coordinate shipment processes of different items and stock points, which means that two or more shipment orders are combined to optimize transportation costs. These consolidation policies have an influence on the leadtime because shipment orders may have to wait before they are shipped to the customer. Therefore, the shipment consolidation policy also has an effect on the required safety stocks.

In this paper we investigate a time consolidation policy where goods are shipped when a shipping date is expired. The stockpoints are controlled by continuous review (s,nQ)-policies and the customers require a specified service level. We model the interaction between the shipment consolidation process and inventory management which enables us to determine simultaneously the optimal inventory and transportation decisions.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 05 (see p. 45 for session)

Kleber, Rainer *(Otto-von-Guericke-Universität Magdeburg)*

A Dynamic Model for Choosing the Optimal Technology in the Context of Reverse Logistics

Product recovery management deals with all activities that are necessary to recover economic value which is still included in used products or materials taken back from the market. In strategic management of product recovery, especially when introducing a new product, two main decision classes have to be considered, namely product design and technology choice. Product design not only influences direct production unit costs, but it also determines required technologies and consequently, necessary initial investment expenditures. With respect to environmental issues, recoverable products usually show higher direct production costs than single use products. On the other hand, it is easier to find a technology to recover a product that has been designed for more than one use and consequently, remanufacturing unit costs are lower. Since the introduction of an environmental friendly technology requires considerable additional expenditures it is questionable whether these will pay off. Taking into account the limited availability of used products in the beginning of a products life cycle and a decreasing time value of the required investment connected with the set-up of the remanufacturing process, the issue has to be addressed when to introduce this process. The possible use of a 'strategic' recoverables inventory represents another option to be considered. This paper is intended to give insights into the simultaneous technology choice and investment time problem within a dynamic deterministic framework consisting of a product life cycle and an availability cycle of returns, of which the relevant properties are derived before. A Net Present Value approach is employed for solving the problem.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 05 (see p. 41 for session)

Kleinau, Peer *(University of Münster)*
Thonemann, Ulrich *(University of Münster)*

Deriving Inventory Control Policies for Periodic Review with Genetic Programming

In Germany, inventories are estimated to be worth of more than 500 billion $. To manage these inventories, numerous inventory-control policies have been developed in the last decades. These inventory-control policies are typically derived analytically, which is often complicated and time consuming. For many relevant settings, such as complex multi-echelon models, there exist no closed-form formulae to describe the optimal solution. Optimal solutions for those problems are determined by complex algorithms that require several iteration steps. With Genetic Programming (GP) however, inventory-control policies can be derived in a simple manner. GP is an algorithm related to Genetic Algorithms. It applies the principles of natural evolution to solve optimization problems. In this paper, we show how closed-form heuristics for a common inventory-control setting with periodic review can be found with GP.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 04 (see p. 49 for session)

Kleindienst, Erich *(University of Mannheim)*
Schneeweiss, Christoph *(University of Mannheim)*

Aggregation of Demand in Supply Chain Management using Approximated Shadow Prices

In supply chain management production planning is often separated into several planning levels. These levels have different degrees of detail and are usually connected by aggregation-disaggregation devices. Particularly aggregate parameters, like aggregate holding cost and capacity consumption rates, are to be determined in an optimal way. Following the aggregation levels of the traditional (MIT) hierarchical production planning approach we are analysing different aggregation devices for an aggregate linear capacity adaptation model and an adjoining detailed mixed integer production model. In particular, focusing on the aggregation of demand we are developing two aggregation procedures in using shadow prices of the inventory balance constraints. An extensive numerical investigation is comparing those new aggregation devices for mixed integer models with the more traditional approaches based on an aggregation of work content and on even simpler aggregation procedures in practice. One of the most crucial questions of aggregating demand is the definition of a suitable common package size. Our general analysis will provide as a special case a proper solution for this central problem.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 04 (see p. 41 for session)

Klohr, Volker *(LOCOM Consulting GmbH, Karlsruhe)*

Planning Methodology and Optimization Approaches for Supply Chains in the Automotive after Sales Business

Logistical Requirements for supply chain planning for service parts in the automotive after sales market and mathematical planning approaches will be described for network structures, inventory management and processes.

1. Introduction to the Supply Chain
    - Structures: Overall supply chain and distribution network
    - Market Requirements: Service parts require efficient supply chains; demands in general are urgent (delivery time $<$ 1 day) and aim at very large number of items.
    - Cost Structures: labor costs are besides facility and tranpostation costs major cost components of the network
2. Network Redesign
    - Locations: how many and where
    - Vertical Structure: Vendors, central depot and field depots
    - Supply Regions: which depot serves a certain demand for a customer
    - Algorithms: genetic location optimization algorithms; network simplex; concave optimization approaches
3. Inventory Planning
    - Fill Rate Targets: order fulfillment at point of sale and warehouses
    - Forecasting Methods: different approaches for autoclassified parts groups
    - Replenishment: Quantity optimization, return and scrapping risk
4. Layout and Proccess Planning for Distribution Centers
    - Equipment: what type of racking for which items
    - Process Control: replenishment processes, pick-pack-ship processes; planning of picking routes; timeline requirements
5. Summary

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 04 (see p. 37 for session)

Kroll, Frank *(SAS Institute GmbH)*

Integrated Procurement and Production Optimization in the Meat Processing Industry

Tulip Food company - one of Europe's largest meat processing companies - offers more than 2,500 meat products. The production process is highly automated and the raw material, i.e., the meat, is the most relevant cost factor. Tulip was looking for an integrated solution in order to optimize their procurement processes in combination with production program planning. The focus of this paper is to illustrate the value chain aspect of this optimization scenario and to characterize the various facets of a successful implementation.

The planning and optimization process consists of three steps, namely budget optimization, procurement optimization and production optimisation: The Budget optimization part of the process which is performed one month ahead fixes the production per week and serves as an input for negotiations with suppliers. The procurement optimization step, which in fact is the core optimization step planned one to two weeks ahead, calculates a detailed production plan on a daily basis. Finally, the production optimization running every night does the scheduling for the following day and feeds its results into the operational systems.

From a supply chain perspective handling the link between procurement and production is the main benefit of this application. Technically speaking, the process of implementing such an optimization solution is a very complex task, whereas the pure mathematical solution of the problem is only one aspect of the whole project. Other relevant success factors were access to external data, data entry, data cleaning on the one hand and visualization/reporting on the other hand; everything packaged within one common interface. As far as the main difficulties are concerned, handling of infeasible solutions and validating input data have to be mentioned.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 05 (see p. 45 for session)

Langella, Ian M. *(Otto-von-Guericke Universität Magdeburg)*

Evaluating the Performance of Heuristics for the Disassemble-to-Order Problem

Remanufacturing, where a firm takes old products back from customers, disassembles them to the part level, inspects the parts, and reassembles these parts into a "good as new" product, has become more visible in industry and received attention in research. Deciding on the amount of returned products to disassemble in order to obtain parts for which we face a given demand (either by external from sales of the parts, or internal demand from a remanufacturing operation), and other related decisions constitutes a disassemble-to-order problem. While in its simplest form this problem is easily solved, increasing the complexity of the product structures and the length of the time horizon leads to drastically increased time required to solve the problem via exact methods (e.g. Integer Programming). This motivates the use of heuristics to solve the problem, and previous work in this area has developed, presented, and improved methods using

heuristics. In this work, the heuristics are tested to determine how far from the optimum costs (obtained using an exact method) the solution obtained from the heuristic provides, over various (i) product structures, (ii) cost scenarios, (iii) demand settings, and (iv) lead times. The goal is to gain insight into heuristic performance over a vast amount of differing scenarios by examining the results and drawing conclusions from them.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 05 (see p. 53 for session)

Leisten, Rainer *(Universität Duisburg-Essen)*

Aspects of Coordinating Program Planning and Lot-Sizing in Production Planning

Program planning and lot-sizing are intensively discussed within production planning systems, in theory as well as in practice. However, even in modern planning systems, the influence of the way these levels are coordinated often is at best treated marginally. We compare several heuristic coordination mechanisms focusing on the aspects of setup anticipation, resource distribution and aggregation. Some numerical results are presented as well.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 04 (see p. 56 for session)

Martin, Roland *(Technical University Darmstadt)*
Tazari, Siamak *(Technical University Darmstadt)*

A Modeling Approach for the Automated Manufacturing of PC Boards

In this paper we present a modeling approach for an optimization problem from the automated manufacturing of PC boards in the modeling language OPL. The mounting machine that is modeled in this approach has features that are not that common in traditional problem descriptions in this field. The first feature is that distinct regions of the same board can be mounted simultaneously by several robot arms that are present on the mounting machine and, on the other hand a robot arm can mount on several boards. The second feature is that the boards move at certain times a certain distance such that the visibility of each robot arm is changed after each movement and therefore new regions of the boards are now visible and the robot arm can now mount in these regions. In this approach we try to benefit from the strengths of ILP modeling as well as from constraint programming. The input is a specified mounting machine and a PC board layout specified by a list of mounting tasks. A mounting task is represented by a position and a component type. The output is a feasible set-up for the machine and a distribution of the mounting tasks to robot arms and time slots. We concentrate on stating the relevant constraints and modeling tricks that describe the new features of the machine.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 05 (see p. 53 for session)

Meißner, Jörn *(Columbia University, Graduate School of Business, New York)*
Federgruen, Awi *(Columbia University, Graduate School of Business, New York)*
Tzur, Michal *(Tel-Aviv University and Northwestern University, Evanston)*

Partitioning Heuristics for the Multi-Item Capacitated Lot Size Problem

This talk addresses the multi-item capacitated lot sizing problem. We consider a family of N items which are produced in or obtained from the same production facility. Demands are deterministic for each item and each period within a given horizon of T periods.

First, we consider the case that a single setup cost is incurred in each period when an order for any item is placed in that period. We develop an exact branch-and-bound method which can be efficiently used for problems of moderate size. For large problems we propose a partioning heuristic. The partitioning heuristic partitions the complete T periods into smaller intervalls, and specifies an associated dynamic lot sizing model for each of these. The intervals are of a size which permits the use of the exact branch-and-bound method.

The partitioning heuristic can, in the single item case, be implemented with complexity $O(T^2 \log\log T)$ and for the general multi-item model, in $O(N^2T^2 \log T \log C^*)$ times where C^* represents the largest among all periods' capacities. We show that our heuristic is $\epsilon-$optimal as $T \to \infty$, provided that some of the models paramters are uniformly bounded from above and from below.

Subsequently, we further generalize the model to include additional item dependend set-up costs and provide extensive numerial studies to evaluate the performance under various data constellations.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 04 (see p. 41 for session)

Melo, Teresa *(Fraunhofer Institute for Insdustrial Mathematics, Kaiserslautern)*
Nickel, Stefan *(Fraunhofer Institute for Insdustrial Mathematics, Kaiserslautern)*
Saldanha-da-Gama, Francisco *(University of Lisbon)*

Dynamic Multi-Commodity Facility Location: A Mathematical Modelling Framework for Strategic Supply Chain Planning

In this talk we focus on the strategic design of supply chain networks. We propose a mathematical modelling framework that captures many practical aspects of network design problems simultaneously but which have not received adequate attention in the literature. The aspects considered include: dynamic planning horizon, generic supply chain structure, external supply of materials, inventory opportunities for goods, distribution of commodities, facility configuration, availability of capital for investments, and storage limitations. Moreover, network configuration decisions concerning the gradual relocation of facilities over the planning horizon are considered. To cope with fluctuating demands, capacity expansion and reduction scenarios are also analysed as well as modular capacity shifts. We show that our modelling framework generalizes many of the models proposed in the literature. Furthermore, we develop a heuristic procedure based on variable neighbourhood search. For problems of reasonable size we report on our computational experience with standard mathematical programming software and assess the performance of our heuristic method. Our numerical results indicate that the heuristic performs very well in many cases. In particular, an analysis of the sensitivity of the solutions obtained to a number of factors is provided.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 05 (see p. 41 for session)

Minner, Stefan *(University of Paderborn)*
Silver, Edward A. *(University of Calgary)*

Multi-Product Replenishment Strategies under a Joint Capacity Constraint

We analyze a multi-product inventory replenishment problem with Poisson demands where the inventory levels at any time are restricted by a common budget or space limitation. We present a Semi-Markov decision problem formulation, several heuristics for finding the replenishment quantities, given the current inventories of all products, and a comparison from a cost performance perspective.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 04 (see p. 56 for session)

Mönch, Lars *(Institut für Wirtschaftsinformatik, Technische Universität Ilmenau)*
Mette, Alexander *(Institut für Wirtschaftsinformatik, Technische Universität Ilmenau)*

Scheduling Jobs with Incompatible Families on a Single Batch Processing Machine Using Tabu Search

We present a method to solve a scheduling problem with incompatible job families for a single batch processing machine. Problems of this type arise, for example, in the diffusion process in semiconductor manufacturing and have great practical relevance. The addressed scheduling problem is NP-hard. Therefore, we suggest a decomposition approach. We form batches in the first phase by using a variant of the Apparent Tardiness Cost dispatching rule. In the second phase we sequence the formed batches using Tabu Search. We implement the Tabu Search algorithm using the object-oriented framework HOTFRAME. This framework provides the infrastructure for implementing different local-search heuristics. We study the behavior of the decomposition heuristic by using stochastically generated test data. We present computational results by comparing the results of our Tabu-Search algorithm with a pure dispatching approach and a partial enumeration approach.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 04 (see p. 37 for session)

Omar, Mohamed Khaled *(Multimedia University, Selangor)*
Yasothei, Suppiah *(Multimedia University, Selangor)*
Siew, Teo *(Multimedia University, Selangor)*

A Mixed Integer Programming Approach for the Development of Production Planning in the Process Industry

The conventional material requirements planning (MRP) and master production scheduling (MPS) systems has gained wide acceptance among production management and control. These are generally regarded as accepted tools of decision support systems (DDS). In this paper, we are addressing a batch processing which occurs predominantly in the process industries. By batch processing, we mean the processing of an integrated, non-divisible unit of product such as volume of resin, polymer, or plastic.

In this paper, we consider further an aggregate optimization model for the usual MRP/MPS. That is under realistic assumption and we are seeking an optimal production pattern (schedule) for the most cost operations subject to various demand and capacity constraints. To this end a mixed integer linear programming formulation is presented and various decompositions schemes are discussed.

This paper is concerned with presenting project research theme statement, framework structure and problem formulation.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 05 (see p. 45 for session)

Ommeren, Jan-Kees van *(University of Twente)*
Bumb, Adriana *(University of Twente)*
Sleptchenko, Andrei *(EURANDOM, Eindhoven)*

Location of Repairshops in a Stochastic Environment

In this paper we investigate the following problem in spare part management. In order to improve its service to the customers, a company decides to open some repairshops close to its clients. There are several locations where the repairshops can be placed. At a repairshop a number of spare parts are kept in inventory in order to insure a high service level. A repairshop can either repair a broken item and add it to the existing inventory or can send it for repair to a central repair facility. When deciding if at a certain location a repairshop will be opened, the company looks at the following costs: the costs of opening the facility, the distance from the customers, the cost of the necessary inventory and the transportation costs to the central repair facility. The solution the company prefers is the one that insures a high quality of service at minimum cost.

We present a stochastic model for this problem together with several heuristics and report on computational experiments.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 04 (see p. 49 for session)

Pibernik, Richard *(Johann Wolfgang Goethe-Universität Frankfurt)*
Sucky, Eric *(Johann Wolfgang Goethe-Universität Frankfurt)*

Planungsmodelle zur Unterstützung eines zentralen und dezentralen Supply Chain Planning

Supply Chain Management (SCM) als das Management unternehmensübergreifender Wertschöpfungssysteme umfasst die zielgerichtete Gestaltung der Supply Chain (SC) sowie die zielgerichtete Koordination der verteilten Leistungserstellung in der SC. Das Supply Chain Planning (SCP) als taktische Planungsebene des SCM hat die Aufgabe, zielgerichtete mittel- bis langfristige Leistungsprogramme für die gesamte SC festzulegen. Sowohl in der relevanten betriebswirtschaftlichen Literatur als auch in kommerziellen Softwaresystemen zur Unterstützung des SCM, sogenannte Advanced Planning Systems (APS), werden zentrale Planungsansätze für das SCP vorgeschlagen bzw. eingesetzt. Ein zentraler Planungsansatz impliziert hierbei, dass ein Entscheidungsträger in der Lage ist, Leistungsprogramme für die gesamte SC festzulegen und vor allem auch durchzusetzen. Dies ist jedoch in der Praxis häufig nicht gegeben: In einer SC agieren i.d.R. autonome Unternehmen, die ihre Leistungsprogramme (weitestgehend) selbständig (dezentral) planen. Es stellt sich die praxisrelevante Frage, wie die Koordination der dezentral geplanten Leistungsprogramme erfolgen kann und wie gut die erzielten Planungsergebnisse im Vergleich zu einer zentralen Planung sind. Im Rahmen des Beitrags wird zunächst ein mehrperiodiges Planungsmodell für die Bestimmung von vorlaufverschobenen Nettoleistungsprogrammen in einer zentral koordinierten SC vorgestellt. Auf der Basis eines praxisrelevanten Beispiels werden die Grenzen dieses Ansatzes aufgezeigt und alternative (dezentrale) Koordinationsformen herausgearbeitet. Für diese dezentralen Koordinationsformen werden Ansätze einer modellgestützten Leistungsprogrammplanung entwickelt und bewertet.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 04 (see p. 53 for session)

Quadt, Daniel *(Katholische Universität Eichstätt-Ingolstadt)*

An Integrated Lot-Sizing and Scheduling Approach for Flexible Flow-Lines

We consider the assembly process of semiconductor manufacturing. The system can be modelled as a flow-line with parallel machines (flexible flow-line). An integrated lot-sizing and scheduling approach is presented that covers backordering, setup times, costs and setup carry-over as well as parallel machines. In its first phase, a single-stage lot sizing and scheduling problem on the bottleneck stage is solved for product families. In phase two, the generated schedule is rolled out to the other production stages. In the third phase, a detailed schedule on individual product level is calculated. Result is a feasible schedule for all product units and stages.

We present a solution procedure based on the approach: In phase one, we employ a new mixed integer programming model embedded in a period-by-period heuristic. Phase two establishes low inventory volumes of intermediate products by establishing similar production rates on all stages. In phase three, two nested Genetic Algorithms are used to schedule the individual products. Computational results are given.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 05 (see p. 49 for session)

Rücker, Thomas *(Technical University Ilmenau)*

Analysis and Optimization of Production Authorization Card Controlled Complex Manufacturing Systems

The Production Autorization Card (PAC) concept by John Buzacott and George Shanthikumar is a general framework for manufacturing control and inventory management, that enables the modelling of different manufacturing control policies like MRP, Kanban, Reorder Point as well as hybrid control of complex systems. A general simulation model was developed and applied in combination with sample path analysis to study linear and assembly manufacturing systems with multiple cells and multiple products. The results will be the basis for the optimization of production and inventory control parameters and for deriving general rules for the adjustment of the PAC system.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 04 (see p. 56 for session)

Schleusener, Martin *(Technical University Berlin)*
Günther, Hans-Otto *(Technical University Berlin)*

Leistungsabstimmung von Produktionslinien in der Elektronikmontage

Hochautomatisierte Produktionslinien haben in der Fertigung von Leiterplatten eine zentrale Bedeutung. Ihre Flexibilität und Effektivität bei der Bestückung von Bauelementen hängt aber in hohem Maße von der Qualität der Algorithmen ab, die zur Steuerung von Bestückungsprozessen einzelner Automaten sowie der Leistungsabstimmung der Linie eingesetzt werden. Ziel ist es, diese beiden Problemfelder zu kombinieren, um die Bestückungszeiten zu minimieren und somit den Output der Produktionslinie zu maximieren. Dies wird erreicht, indem die Bauelemente, die auf einer Leiterplatte zu bestücken sind, den einzelnen Automaten der Linie so zugeordnet werden, das ein Belastungsausgleich zwischen allen Automaten erreicht wird. Zu beachten sind hierbei aber ebenso technische Eigenschaften der einzelnen Automaten einer Linie, denn nicht jeder Automat kann z.B. jeden Bauelementtyp bestücken.

In der bisherigen wissenschaftlichen Literatur werden die unterschiedlichen Eigenschaften der Automaten kaum bzw. gar nicht berücksichtigt. Unser Ansatz unterscheidet sich von den vorhandenen Problemlösungen durch die Einbindung der Automatenoptimierung mit einem sehr hohen Genauigkeitsgrad. Hierzu wurde basierend auf den Erfahrungen in der Optimierung modularer Bestückungsautomaten ein mehrstufiger Algorithmus entwickelt, der sowohl den Belastungsausgleich zwischen den Automaten der Linie als auch die Optimierung auf Automatenebene integriert.

In der ersten Stufe werden Optimierungsalgorithmen auf Automatenebene angewendet, um die Automaten vergleichende Kennzahlen für die Bestückungsleistung der einzelnen Automaten zu bestimmen. Des Weiteren dienen diese Kennzahlen als Grundlage für die zweite Stufe des Algorithmus, der Prioritätsregeln zur Verteilung der Bauelementtypen sowie zur Berücksichtigung der Magazinplatzrestriktionen der einzelnen Automaten verwendet. Die dritte Stufe führt letztendlich unter die Leistungsabstimmung durch.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 05 (see p. 56 for session)

Schneider, Torsten *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*

A New TSP-Based Heuristic Approach to Load Balancing in a Conveyor Flow Shop

Sequencing methods for flow shop problems usually strike for the goal of minimizing the makespan, often ignoring the dynamic workload distribution issues. In this talk, a new multi-objective sequencing method will be presented which is aimed at effective load balancing over time and preventing short-term peak loads.

A conveyor-based production line with linear arranged work stations will be considered in which the makespan is determined by given values of the infeed frequency and the line speed. The orders, while being processed, remain on the continuously moving conveyor. Each order has to be served by a subset of work stations, and each work station processes a subset of orders. This setup, in a similar form, is known as the conveyor flow shop problem and characterizes a typical situation in logistic systems, e.g. in picking systems of mail order houses.

In such a system, if the incoming orders are processed without pre-sequencing, strong fluctuations in the load of the work stations have to be expected, accompanied by frequent overload situations. Hence, methods are required which can prevent such peak loads by optimizing the order sequence.

The proposed solution is based on a TSP-approach, which was extended via the capability of handling multiple objectives and real-time issues to comply with the specifics of the above problem. The algorithm takes advantage of a dynamic weighting of objectives during the solution process and can handle problems with a great number of working stations and orders. In industrial applications, the approach demonstrated its ability to practically eliminate short-term workload peaks and to reach an essentially improved load balancing.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 04 (see p. 53 for session)

Schömig, Alexander *(Infineon Technologies AG)*
Mittler, Manfred *(Infineon Technologies AG)*

On Experiences Using the Operating Curve Methodology for Controlling and Performance Evaluation of Semiconductor Chip Manufacturing

In 1997 Infineon Technologies (then: Siemens AG semiconductor division) started the Productivity Offensive. This project aimed at improving the capital efficiency of the fabs located at Regensburg (Germany), Munich-Perlach (Germany), and Villach (Austria) by focussing on improving production logistics and shop floor operations without any capital expenditure. The Operating Curve Methodology was introduced as the standard factory productivity measurement tool and as a basis for new key performance indicators. In the meanwhile, this methodology has been rolled out to all Infineon sites world wide.

We discuss the experiences concerning the application of this methodology, by presenting several examples including controlling and reporting, performance evaluation of work centers, and data sampling issues. We also elaborate about shortcomings of the operating curve methodology and present possible directions for future research.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 04 (see p. 37 for session)

Schoner, Peter *(Universität Kassel)*

Ein heuristisches Verfahren auf Basis von Prioritätsregeln zur Produktionsplanung in der Prozessindustrie

Die Prozeßindustrie umfaßt die Branchen Nahrungsmittel-/Getränkeindustrie, Chemische Industrie sowie Pharmaindustrie und ist neben einigen Großunternehmen durch zahlreiche kleine und mittelständische Betriebe gekennzeichnet. In diesen Unternehmen werden die Produkte größtenteils nur in zwei- bis dreistufige Produktionsverfahren hergestellt.

Die Produktionsplanung ist geprägt von der Einhaltung der Kundenwunschtermine. Vorrangiges Ziel ist die Planung und Terminierung der Produktionschargen. Dabei müssen verschiedenste Randbedingungen berücksichtigt werden, wie die Auswahl der geeigneten Produktionsanlagen, Lagerung von Zwischenprodukten und Reinigung der Produktionsanlagen. Die Planung muß hierbei flexibel auf Änderungswünsche und die Einplanung neuer Aufträge reagieren können. Eine Planung unter betriebswirtschaftlichen Gesichtspunkten findet nicht statt.

In dem Beitrag wird ein heuristisches Verfahren auf Basis von Prioritätsregeln vorgestellt. Durch die Kombination der Prioritätsregeln können unterschiedliche Planungsszenarien simuliert und terminliche gegen betriebswirtschaftliche Ziele abgewogen werden.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 04 (see p. 41 for session)

Schröder, Michael *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Kalcsics, Jörg *(Universität des Saarlandes, Saarbrücken)*
Nickel, Stefan *(Universität des Saarlandes, Saarbrücken)*

Fast Heuristics for Territory Design

The alignment of territories within a given region is required in applications like sales territory alignment, design of service districts, or zoning of electoral districts. In such applications the territories typically must have similar characteristics and reasonable geographical properties. Territories are formed by grouping together small basic areas. In real-world problems we often have many thousands of such basic areas.

In this paper we focus on heuristics for territory design for which speed in terms of running time is a critical factor. In such heuristics e.g. operations with quadratic time complexity (like the computation of all pairwise distances of the basic areas) are prohibitive.

We will present two approaches for fast heuristics for territory design. Therein the basic areas are represented as points in the plane. In the first approach we solve a network flow problem on the Gabriel graph of the set of points to yield a tree, which is then partitioned into subtrees of similar characteristics. The second approach has been termed

"successive dichotomies" in the literature and consists mainly in bi-partitioning subsets of the set of basic areas in a hierarchical fashion. The bi-partitioning step is performed efficiently by computational geometry methods.

Some of the heuristics presented are part of a commercial planning tool for geo-marketing, the so-called *Business Manager* of *geomer GmbH*, Heidelberg.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 04 (see p. 45 for session)

Schulte, Gregor *(Technical University Dresden)*

Unternehmensübergreifende Losgrößenplanung mit dem Verfahren nach Blackburn-Millen

In diesem Vortrag wird untersucht, welche Vorteile sich aus dem Einsatz des dynamischen Losgrößenverfahrens von Blackburn-Millen (für konvergierende Erzeugnisstrukturen) in der Supply Chain ergeben können und welche Probleme damit verbunden sind. Zunächst ist ein Vorgehen zu finden, um das für die interne Planung konzipierte Verfahren überhaupt unternehmensübergreifend einsetzen zu können. Ein Aspekt ist hier bspw. die Verwendung aggregierter Daten auf Unternehmensebene, wodurch der Rahmen des Losgrößenmodells von Blackburn-Millen (Maschinenebene) verlassen wird. Dafür werden verschiedene Möglichkeiten diskutiert und anhand von Simulationsergebnissen bewertet. Im Anschluss an die Untersuchung der theoretischen Durchführbarkeit folgen Betrachtungen möglicher Probleme bei der tatsächlichen Durchführung. Dazu zählen z. B. die Gewährleistung einer wahrheitsgemäßen Informationsübermittlung bezüglich der zwischen den Unternehmen ausgetauschten Größen (insbes. Rüst- und Lagerhaltungskostenwerte) und die Aufteilung des generierten Zusatzgewinns unter den Teilnehmern.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 05 (see p. 49 for session)

Schwindt, Christoph *(Universität Karlsruhe)*
Trautmann, Norbert *(Universität Karlsruhe)*

Scheduling with Storage Resources

In many practical scheduling applications, inventory constraints like the schedule-dependent availability of input products or the scarcity of storage space for output products have to be taken into account. In commercial production planning systems, a preprocessing step usually translates those inventory constraints into precedence relationships between operations producing and operations consuming a given intermediate product. In case of divergent or general product structures, however, the ex-ante pegging of producing and consuming operations generally leads to the loss of optimality. In this talk we show how based on the concept of storage resources, inventory constraints can be dealt with during the scheduling process. To this end, each intermediate product is assigned to a storage resource with a given safety stock and storage capacity. We discuss two alternative approaches to scheduling with storage resources: a relaxation-based branch-and-bound procedure for small- and medium-sized problem instances and a constructive priority-rule method dedicated to large-scale instances. The branch-and-bound algorithm is based on the relaxation of the inventory constraints. Inventory shortages and storage-capacity overflows are stepwise resolved using two types of precedence relationships between appropriate operations. The priority-rule method consists of two phases. During the first phase, the operations are iteratively scheduled in such a way that the inventory does not fall below the safety stock at any point in time. Based on the resulting schedule, precedence constraints between replenishing and depleting operations are introduced according to the FIFO strategy. In the second phase, the operations are then scheduled subject to the storage-capacity and the precedence constraints introduced, avoiding deadlocks by means of a specific unscheduling technique. Computational experience is reported for the minimum-makespan problem in batch production scheduling.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 05 (see p. 37 for session)

Spitter, Judith Maria *(Technische Universiteit Eindhoven)*
Kok, Ton G. de *(Technische Universiteit Eindhoven)*
Dellaert, Nico P. *(Technische Universiteit Eindhoven)*

Methods for Balanced Allocation in Mathematical Programming Models for Supply Chain Operations Planning

We consider Supply Chain Operations Planning (SCOP) in a rolling horizon context under demand uncertainty. The supply chain structures we handle are arbitrary, and the available resources have limited capacity. Arbitrary Supply Chains may consist of both convergent and divergent structures. The SCOP problem is solved using Linear Programming (LP) models. LP models are only suitable for solving deterministic problems. Hence we solve SCOP problems using a forecast of the demand for a certain time horizon, in a rolling horizon context. For the divergent structures in the Supply Chain there is always an allocation problem, when parent items demand exceeds item availability. When optimizing production plans with LP models, solutions are found in extreme points. So in the allocation problem for divergent structures, LP will also give an extreme point as solution. Since the SCOP problem is solved in a rolling horizon with stochastic demand, the obtained allocation by LP may not be optimal. To obtain balanced solutions we

propose two methods. In the first method allocation rules are added to the LP problem. These allocation rules allocate the shortage of an item to its parent items proportionally. In the second model we use a quadratic objective function. The weight factors in the quadratic objective function influence the allocation problem in the divergent structures. Since the demand for finished products is stochastic, good allocation rules or weight factors decrease the inventory costs.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 04 (see p. 37 for session)

Sürie, Christopher *(Technische Universität Darmstadt)*

Campaign Planning with Time-Indexed Model Formulations

This talk deals with a production planning problem typical for the process industries. There the production amount of one continuous production run - referred to as a campaign - is often constrained by a lower and/or upper bound or such that it has to be in multiples of a pre-defined batch size. For this kind of problem a new mixed-integer-programming (MIP) model formulation is proposed, which is based on a standard lot-sizing model with uniform time-buckets. Thereby the concept of time continuity is integrated into a standard bucket-oriented lot-sizing model formulation. The model formulation is further enhanced by valid inequalities. Extensive computational tests show that this new model formulation clearly outperforms a benchmark model formulation taken from literature. Furthermore, they show the additional computational effort associated with different types of restrictions imposed on campaigns.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 04 (see p. 45 for session)

Sural, Haldun *(Middle East Technical University, Ankara)*
Nalca, Arcan *(Middle East Technical University, Ankara)*

Coordination in Economic Production Quantities

In this study we consider a system consisting of an assembler and a group of suppliers, and producing a single product with a constant demand rate. Suppliers manufacture the product components at unequal rates. The components are assembled by the assembler. What is then the optimal lot size (of product and its components)? That will depend on whether one seeks system optimality, corresponding to a centralized system, or whether the assembly firm dictates to the suppliers the lot size it prefers. We develop a model to compare the effects of centralized and decentralized decisions on the total cost of the system. We show that total costs are higher in the decentralized system.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 05 (see p. 49 for session)

Trautmann, Norbert *(Institut für Wirtschaftstheorie und OR, Universität Karlsruhe)*
Schwindt, Christoph *(Institut für Wirtschaftstheorie und OR, Universität Karlsruhe)*

A Priority-Rule Based Method for Batch Production Scheduling in the Process Industries

We present a priority-rule based method for batch scheduling in the process industries. The problem consists in scheduling a given set of operations of different types on a batch plant such that the makespan is minimized. An operation consumes prescribed amounts of input materials at its start and produces prescribed amounts of output materials at its completion. An initial, a maximum, and a minimum stock level are given for each material. Some materials are perishable and thus cannot be stored. Each operation is executed on a processing unit of a certain type. A processing unit needs to be cleaned between consecutive operations of different types and before any idle time.

Due to the constraints on material availability and storage capacity, classical schedule-generation schemes cannot be applied to this problem. The basic idea of the new priority-rule based method is as follows: In a first step, we relax the storage-capacity constraints. For this relaxation we compute a feasible schedule by applying the serial schedule-generation scheme, where we additionally take the material-availability constraints into account. In a second step, for each material we match producing with consuming operations according to the FIFO strategy and establish corresponding precedence relationships between these operations. In a third step, we compute a feasible schedule for the resulting expanded problem by again applying the serial schedule-generation scheme, where now we take the storage-capacity constraints into account.

We compare the performances of the new method and alternative solution methods from literature. The test set consists of problem instances that have been obtained by varying the primary requirements for final products in a case study described by Westenberger & Kallrath (1995). For problem instances of practical size, the new method outperforms the procedures known from literature.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 05 (see p. 37 for session)

Zillus, Andrea *(Institut für Fördertechnik und Logistiksysteme, Universität Karlsruhe)*
Furmans, Kai *(Institut für Fördertechnik und Logistiksysteme, Universität Karlsruhe)*

Waiting Time Probabilities for Customer Orders in a Supply Chain

Lead time and its reliability have become the main performance measures for a company's success. The goals today are a high level of customer service as well as the ability to respond to a changing environment. For supply chain analysis and optimization however there are other performance measures utilized. Apart from costs usually the service level or fill rate is applied in most of the theoretic approaches. The lack of lead time and other time-based performance measures is stated by some authors.

From the customer's point of view lead time is the waiting time for a customer order to be filled. The topic of this paper is the *determination and evaluation of customer orders' waiting time distribution*. Not only the length of the waiting time is of interest but also its variation, i.e. the probability for a certain waiting time, identifying lead time reliability.

The method for calculating the waiting time distribution for customer orders in a supply chain has been developed and is presented next. The method is based on the method published by Tempelmeier in 1985 and 2000 for a single stage inventory system. The extensions to this method concern the determination of internal order distribution (in contrast to customer order distribution) within the supply chain as well as the calculation of lead time distributions within the supply chain. These depend on the supply chain configuration, i.e. the structure of the supply chains (production sites, warehouses, etc.) and the logistics strategies (make-to-order or make-to-stock, transportation and inventory policy). The method works for arbitrary serial supply chains with given discrete time distributions.

The analysis of a supply chain using this method is shown for an currently discussed task: The positioning of the order penetration point in a supply chain. The results show the impact of different order penetration points of a particular supply chain to the customer order waiting time distribution.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 04 (see p. 56 for session)

Zimmermann, Jens *(Inst. f. Automatisierungs- und Systemtechnik, Technische Univ. Ilmenau)*
Otto, Peter *(Inst. f. Automatisierungs- und Systemtechnik, Technische Univ. Ilmenau)*
Mönch, Lars *(Inst. f. Wirtschaftsinformatik, Technische Univ. Ilmenau)*

Anwendung von Verfahren des maschinellen Lernens auf das Scheduling von Jobs auf Batchmaschinen in der Halbleiterindustrie

Wir stellen eine Methode vor, die eine Lösung von dynamischen Schedulingproblemen mit inkompatiblen Jobfamilien und zukünftigen Jobankünften für parallele Batchmaschinen ermöglicht. Probleme dieses Typs treten zum Beispiel im Hochtemperaturbereich des Frontendbereichs von Halbleiterfabriken auf und haben große praktische Bedeutung. Falls Informationen über zukünftige Jobankünfte bekannt sind, ist es oft vorteilhaft, einen nicht voll ausgelasteten Batch zu bilden. In anderen Situationen besteht eine günstigere Strategie darin, auf bestimmte zukünftige Jobankünfte zu warten und erst dann den stärker ausgelasteten Batch zu starten. Als Zielfunktion verwenden wir die gewichtete Verspätung. Für diese Zielfunktion hat sich die Apparent Tardiness Cost (ATC) Prioritätsregel als günstig erwiesen. Die Anwendung dieser Prioritätsregel verlangt die Festlegung eines Skalierungsparameters. Von der Wahl dieses Parameters hängt in starkem Maße ab, welche Werte für die gewichtete Verspätung erreicht werden können. Wir verwenden neuronale Netze und Entscheidungsbäume, um eine günstige Festlegung des Skalierungsparameters zu ermöglichen. Es werden dazu für eine gegebene Jobmenge bestimmte charakteristische Größen berechnet. Diese werden dann an das neuronale Netz bzw. den Entscheidungsbaum übergeben, um einen optimalen Skalierungsparameter zu bestimmen. Wir stellen die Ergebnisse von numerischen Experimenten vor.

4.4 Section 4: Services, Transportation and Traffic

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 56 for session)

Andersson, Per-Åke *(Department of Mathematics, Linköping University)*

Multi-Year Planning of Maintenance Operations of Public Roads

In Sweden around MEUR 300 are spent each year for the maintenance of the paved state road network. The state of each of around 150000 road segments is measured regularly by the Swedish National Road Administration (SNRA), and its future state is forecasted.

The multi-year planning problem is when to maintain which paved road segments by what rehabilitation actions, minimising the overall user traffic cost subject to overall yearly budget constraints. The default option is routine

maintenance, more expensive as the road surface deteriorates. SNRA refers each road segment to a unique road class, depending on traffic load and climate. In the pavement management system SNRA registers both road constants and dynamic data.

We have set up an optimization model of the multi-year maintenence planning problem, and applied to a geographically limited subnetwork. Four state dimensions of dynamic road conditions are distinguished and a fixed set of maintenance types is applied. The traffic costs are determined by technical models of traffic effects, e.g. travel time, and the political cost valuation of these effects. Since the maintenance costs and the deterioration rates are given only for classes in state space for each road class, our data for the road segments become semi-synthetic. In practice, we let representative class values define the state nodes in a basic discretization, and apply interpolation. Rehabilitation trigger levels of bad road conditions are treated by penalty costs.

Dual decomposition is applied by a relaxation of the budget constraints, separating the problem into one subproblem for each road segment. Dynamic programming is used for solving the subproblems. The updating of dual multipliers is subgradient based. To provide the main routine with relevant multiplier values and rest values, in a special start routine only the road classes are distinguished, and the road segments are partitioned among neighbour state nodes.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 56 for session)

Brecht, Winfried *(HTWK Leipzig)*

Optimale Allokation von Aufgaben und Ressourcen in Servicebereichen

Während in Produktionsbereichen von Industriebetrieben überwiegend Maschinen die leistungsbestimmenden Ressourcen darstellen, sind es in Servicebereichen meist die Human Ressources in Gestalt von Mitarbeitern. Während demzufolge für Produktionsbereiche die Maschinenbelegung mit Aufträgen eine hervorragende Rolle in der operativen Planungstätigkeit spielt, übernimmt diese Rolle für Dienstleistungsbereiche eine wochenbezogene Personaleinsatzplanung, die ausser einer An- und Abwesenheitsplanung (days off scheduling) sowie einer Schichtplanung (shift scheduling) auch zeitliche Aufgabeneinordnungen unter variablen Mitarbeiterzuweisungen zu bewältigen hat.

Zeitliche Aufgabeneinordnungen besitzen zunächst noch keine besondere Bedeutung für stark kundenfrequentierte Servicebereiche (Kassenbereiche von SB-Märkten, Reisezentren der Bahn, Call-Center etc.), in denen gleichartige Aufgaben im Tagesverlauf massenhaft anfallen und möglichst ohne Zeitverzug realisiert werden müssen. In diesen Bereichen werden meist anhand der zu erwartenden Bedarfsfälle (Kundenzahlen etc.) und Abfertigungszeiten pro Bedarfsfall (oder gröberen Produktivitätszahlen) verlässliche Personalbedarfszahlen im feinen Zeitraster (z.B. im 30- oder 15-Minuten-Raster) abgeleitet und auf dieser Grundlage wochenbezogene Personaleinsatzpläne erarbeitet. Dass solche wochenbezogenen Personaleinsatzplanungen auch mittels Optimierung realisierbar und dadurch beachtliche Effekte erreichbar sind, hat der Verfasser bereits mit Hilfe seines 1996/97 entwickelten und seitdem ständig weiterentwickelten Softwaresystems "PEPO" in über 30 Studien für unterschiedlichste Anwendungsbereiche anhand von zahlreichen computergetützten Optimierungsexperimenten nachgewiesen.

Hier soll gezeigt werden, durch welche Erweiterungen des in PEPO zugrundegelegten Modells neben den zeitbezogenen auch die aufgabenbezogenen Mitarbeitereinsätze optimiert und welche Effekte dadurch erreicht werden können.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 09 (see p. 42 for session)

Cardeneo, Andreas *(Institute for Conveying Technology and Logistics, University of Karlsruhe)*

An IP/CP Solution Procedure for the Vehicle Routing Problem with Alternative Drop Points and Time Constraints

The vehicle routing problem with alternative drop points and time constraints is an optimization problem arising in the domain of business to consumer distribution logistics.

When consumers specify multiple delivery options, each defined by location and time-window, the carrier faces the problem of determining an optimal routing for a given fleet of homogeneous vehicles where for each customer one of its drop points is chosen and the total distance travelled is minimized.

The algorithm presented is based on an IP formulation solved by column generation where the subproblem is solved using constraint programming. In order to speed up search several pruning techniques are used.

The performance and solution quality of the exact solution method are presented. Furthermore, a logistical evaluation shows the cost reduction potential of including alternatives and presents perspectives for logistics management.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 53 for session)

Daduna, Joachim R. *(FHW Berlin)*

Personal- und Fahrzeugeinsatzplanung in der Müllentsorgung

Die operative Personal- und Fahrzeugeinsatzplanung in der Müllentsorgung ist bisher als ein in sich geschlossener

Prozess angesehen worden, bei dem Fahrzeug und Fahrer sowie das Ladepersonal eine (nicht trennbare) Einheit bilden. Aufgrund von Veränderungen in den Randbedingungen, u.a. durch zunehmende Entfernungen zwischen Aufkommensgebieten und den verschiedenen Zielorten (Deponie, Recyclinganlagen, etc.), und einem verstärkten Kostendruck ergeben sich neue Anforderungen. Um diesen gerecht zu werden, müssen neue Wege gesucht werden, die auch bestehende Strukturen aufbrechen.

Mit der Auflösung der Planungseinheit Fahrzeug / Fahrer / Ladepersonal besteht eine Möglichkeit, die verfügbaren Ressourcen effizienter zu nutzen. So ist anzustreben, dass das Ladepersonal bei längeren Fahrten am Abschluss einer Sammeltour zu einem Umschlagpunkt, nicht (untätig) auf dem Fahrzeug verbleibt, sondern einem anderem Fahrzeug zugeordnet wird. Hier bieten sich zwei Lösungsansätze an, zum einen ein zweistufiger Ansatz, bei dem zunächst eine Tourenplanung für die Fahrzeuge und Fahrer erfolgt und anschließend eine Zuordnung der Ladecrews zu den entsprechenden (produktiven) Tourabschnitten, sowie zum anderen ein simultaner Ansatz, der allerdings eine sehr komplexe Struktur aufweist.

Es bieten sich daher zweistufige Ansätze an, bei denen zunächst ein Capacitated Arc Routing-Problem gelöst wird. Ausgehend von den in dieser Lösung enthaltenen "produktiven" Anteilen ist ein (klassisches) Duty Scheduling-Problem zu lösen. Allerdings lassen sich hierbei bestehende räumliche und zeitliche Interdependenzen zwischen dem Verlauf der Touren und dem Personaleinsatz nicht berücksichtigen. Aufgrund der Komplexität einer solchen Problemstellung bietet es sich an, ausgehend von einer in einem zweistufigen Ansatz ermittelten Startlösung, zur Ermittlung einer günstigen Lösung geeignete heuristische Verbesserungsverfahren einzusetzen. Ein auf diesen Überlegungen aufbauender Ansatz wird vorgestellt.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 53 for session)

Dohmen, Lothar *(Forschungsinstitut für Rationalisierung an der RWTH Aachen)*

Ein mathematisches Simulationsmodell für die Abfuhrplanung in der kommunalen Abfallentsorgung

Die Anforderungen an die Abfuhrplanung in der kommunalen Abfallentsorgung sind sehr hoch. Darüber hinaus haben sich diese Anforderungen aufgrund des technischen Fortschritts und gesellschaftlichen Wandels in Deutschland in den letzten Jahren stark verändert. Dies hat aufgrund fehlender Forschungsarbeiten dazu geführt, dass keine ganzheitlichen Modelle und Verfahren und keine angemessenen Planungsprogramme für die kommunale Abfallentsorgung existieren. Deshalb wird die Abfuhrplanung bis heute vorwiegend manuell durchgeführt, obwohl Kosteneinsparungspotentiale von 15-20 % bei Sammlung, Umschlag und Transport in der kommunalen Abfallentsorgung durch den Einsatz automatischer Tourenplanungsprogramme mit neuen Planungsverfahren vermutet werden.

Ziel dieses Forschungsprojekts ist die Entwicklung eines Verfahrens für die Abfuhrplanung in der kommunalen Abfallentsorgung unter Berücksichtigung verschiedener Sammeltechnologien und naturanaloger Optimierungsmethoden. Mit diesem Planungsverfahren wird es möglich sein, die Güte und den Aufwand der Abfuhrplanung zu optimieren. In dem Verfahren werden Abfuhrrhythmen und Sammelfahrzeugflotte simuliert, sowie Touren, Reviere und Umschlagsplätze bzgl. der Gesamtkosten für Sammlung, Umschlag und Transport optimiert. Bei dem betrachteten Optimierungsproblem handelt es sich somit um eine Kombination eines multiplen kapazitierten Tourenplanungsproblems mit heterogener Fahrzeugflotte und eines einstufigen multiplen Standortplanungsproblems. Das Forschungsprojekt beinhaltet neben dem Entwurf eines mathematischen Simulationsmodells die Entwicklung eines Planungsverfahrens auf Basis einer naturanalogen Optimierungsmethode sowie dessen prototypische Implementierung und exemplarische Anwendung. In diesem Beitrag wird ein Überblick über das Projekt gegeben, wobei der Schwerpunkt auf dem mathematischen Simulationsmodell liegt.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 09 (see p. 49 for session)

Fabri, Anke *(Operations Research und Wirtschaftsinformatik, Universität Dortmund)*
Recht, Peter *(Operations Research und Wirtschaftsinformatik, Universität Dortmund)*

On Dynamic Pickup and Delivery Vehicle Routing with Several Time Windows and Waiting Times

In 2001, A. Pacifici and his coauthors introduced a fast and efficient heuristic for routing a fleet of vehicles for dynamic combined pickup and delivery services, consisting of a dynamic programming approach solving the single vehicle routing problem and an assignment problem. This algorithm is now adapted to the dynamic pickup and delivery vehicle routing problem with several time windows admitting waiting times for vehicles. Moreover, local search techniques using free computation capacities are added to improve considerably the computational times.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 09 (see p. 56 for session)

Fügenschuh, Armin *(Technical University Darmstadt)*
Martin, Alexander *(Technical University Darmstadt)*

Simultaneous Optimization of School Starting Times and Public Bus Services

In many rural areas, the public bus service is demand-oriented: By far the biggest group of customers are pupils who

are transported to their schools within certain strict time limits. Usually, all schools start around the same time, which causes a morning peak in the number of deployed buses. However, schools are allowed to change their starting times within some intervall. The question is, how to simultanenously rectify the starting times for all schools and bus trips in a certain county so that the number of scheduled buses is minimal. We present a mixed-integer programming formulation for this optimization problem and address its solution for some real-world instances.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 09 (see p. 45 for session)

Galia, Rastislav *(Carmen Systems)*

Column Generation for Crew Pairing

An important problem in airline planning process is creation of anonymous lines of work, pairings. Problem can be described by cost function (real airline costs), legality rules for each line of work and general linear constraints, that involve several pairings.

Column generation technique can provide high quality solutions that is required by airlines. The technique relies on several assumptions, such as additivity of the cost function and constraint contributions, that make it difficult to apply in the production.

The difficulties are made more severe by requirements of flexibility and configurability, meaning that airlines wish to write and modify the legality rules and costs. In order to allow users to have a maximal control over the rules and costs, rule system can be provided. They can have form of expression-evaluation language, appearing as black-box to the optimization software. However, generality of such limited interface causes problems to the column generator.

The solutions to these challenges are proposed, based on proper granularity of the pricing problem, k-shortest paths and application of the resource-constrained shortest paths and to the modelling of non-additive cost functions. Impact of techniques such as label merging or connection fixing is discussed as well.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 56 for session)

Galiano, Graziano *(University of Roma Tor Vergata)*
Carotenuto, Pasquale *(ITIA CNR, Rome)*
Giordani, Stefano *(University of Roma Tor Vergata)*

A Metaheuristic Approach for Hazardous Materials Transportation

The transportation of hazardous materials is a growing problem due to the increasing transported volumes; in fact, huge quantities of hazardous materials are yearly produced and the production of them goes together with their transportation. What differentiates hazardous material shipments from shipments of other materials is the risk associated with an accidental release of hazardous materials during transportation; this can be extremely dangerous both with respect to the environment and to human health. A possible solution to reduce the occurrence of dangerous events is to provide travel plans that establish a fair spatial and temporal distribution of the risk. The objective of this work is to study the problem of routing and scheduling a set of hazardous materials shipments, minimizing the travel total risk while spreading the risk among different zones of the geographical region where the transportation network is defined. We propose a genetic algorithm that, given a set of dissimilar routes for every origin-destination pair, selects a route and defines a starting time for every shipment with the aim of minimizing the total risk of the travel plans. The genetic algorithm is experimentally evaluated on a set of realistic scenarios defined on a regional area.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 09 (see p. 38 for session)

Garn, Wolfgang Walter *(Telekom Austria AG / BMR / Operations Research, Universität Wien)*
Polacek, Michael *(Institut für Betriebswirtschaftslehre / Produktion und Logistik, Universität Wien)*
Bomze, Immanuel *(Telekom Austria AG / BMR / Operations Research, Universität Wien)*

A Real-World S-MD-mVRP-TW

The primary goal of this project was to find out the period of time that allowed a maximum cutback on distance. One difficulty encountered was the dynamic scheduling related to the vehicle routing based on stochastic information. The parameters given were the location of customers (random in space), their random service times, which occurred based on a certain distribution, and a mainly fixed number of vehicles.

Although the depot locations are known, we nevertheless investigated improved locations in respect to the mean travel distance by using an equi-partition algorithm and other popular cluster algorithms. We also looked at rural and city areas and performed research on classical space distributions, to find correlations between the saving period and the number of customers.

In this paper, we will present principles of finding an adequate time for a customer-area to be revisited, in a real-life scenario. We will demonstrate by examples the implications of changing the number of teams and depots, taking an equi-partition approach combined with the classical Clarke-Wright VRP combined with TSP smoothing.

These results will be compared with a sophisticated VRP implementation based on Variable Neighbourhood Search (VNS), where the main idea is to perform a repeated descent to a local optimum based upon a (random) perturbation of the incumbent solution. The extent of perturbation progressively increases over time to allow overcoming local optimality.

Continued execution of this method takes full advantage of the given circumstances, e.g., scheduling is improved by classifying as many time windows as possible to reduce the stochastic element. In turn, the scheduling process interacts with solutions of the vehicle routing problem and involves consideration of future customers. As a result, the services offered to customers will have reached a higher and better degree while the number of vehicles and depots are reduced.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 09 (see p. 56 for session)

Gnutzmann, Stefan *(Daimler-Chrysler AG, Berlin)*

Standortplanung der Ticketautomaten zur elektronischen LKW-Maut

Voraussichtlich zum 31.8.2003 soll in Deutschland ein streckenbezogenes, elektronisches Mautsystem auf den Autobahnen für Lkw über 12 t eingeführt werden. Neben einer Bezahlung über Internet oder spezieller Bordcomputer werden Ticketautomaten bereitgestellt. Dieser Vortrag berichtet über die Methoden, die bei der Standortauswahl verwendet wurden.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 09 (see p. 49 for session)

Grünert, Tore *(LuF Operations Research und Logistik Management, RWTH Aachen)*
Funke, Birger *(GTS Systems and Consulting GmbH, Herzogenrath)*
Irnich, Stefan *(LuF Operations Research und Logistik Management, RWTH Aachen)*

Local Search for Vehicle Routing and Scheduling Problems (Part II): Search Techniques

The second part of the talk focuses on the following aspect: Given a neighborhood in a VRSP, how can one search it efficiently in order to reach a local optimum as quickly as possible? We will distinguish between two approaches: *direct search by enumeration* and *indirect search by optimization.*

By direct search we mean approaches that subsequently perform partial moves and evaluate the result of these operations directly. Usually one can consider these approaches as some type of tree search method. We will discuss two search trategies, namely *sequential search* and *lexicographic search*. The first of these methods is motivated by the desire to cut off large parts of the search tree by considering partial gains that result from the application of a subset of the partial moves. The well-known Lin-Kernighan algorithm exploits this idea. On the other hand, lexicographic search considers the possible feasibility of a move after a subset of its constituting partial moves have been applied.

Indirect search methods try to map the problem of finding an improved solution in the neighborhood into some optimization problem, such as a shortest path, assignment, or constraint programming problem. The search is then equivalent to discovering a suitable optimization algorithm or heuristic for solving this problem. We present different approaches to this type of large-scale neighborhoods: move composition graphs and the set-packing formulation, cyclic improvement graphs, and cluster-partition graphs.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 09 (see p. 38 for session)

Grünert, Tore *(LuF Operations Research und Logistik Management, RWTH Aachen)*

Generic Modelling and Algorithms for Real-World Vehicle Routing and Scheduling Problems

We present a framework for modeling and heuristic solving of large-scale real-world vehicle routing and scheduling problems (VRPSs). Real-world problems have in common that their size is usually large or very large (including thousands of requests) and that they include a number of side constraints that are not present in the abstract standard models. Examples of such constraints include sorting capacities at locations, complex driver regulations, prescribed loading and unloading sequences etc.

The purpose of our framework is to enable the design of a class of template heuristics that will be applicable to solving a large class of VRPSs without knowing all relevant constraints in advance. This approach is similar to the use of templates and virtual functions in object-oriented programming and has also been suggested, although with a different focus, namely for solving VRSPs by column generation, in the Operations Research community. Here, the main idea is to model inter- and intra-route constraints by a set of so-called resource variables. Based on a slightly extended

version of the resource model, we present a so-called generic model for VRSPs and discuss a set of algorithms to solve instances of this model.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 09 (see p. 42 for session)

Homberger, Jörg *(Berufsakademie Stuttgart)*

Ein hybrider genetischer Algorithmus zur Transportdisposition im Lieferservice

Ausgangspunkt des Beitrages ist ein konkretes betriebliches Tourenplanungsproblem eines großen deutschen Konzerns mit Schwerpunkt im Lebensmittel-Einzelhandel. Im Rahmen der Entwicklung neuer Vertriebswege wird dort seit einiger Zeit Einzelhandels-Kunden eine Bestellmoeglichkeit über das Internet angeboten. Gegen eine pauschale Servicegebuehr werden bestellte Waren durch den Lieferservice des Einzelhandels-Unternehmens zusammengestellt und anschliessend durch beauftragte externe Spediteure zum Kunden geliefert. Für den Lieferservice stellt sich das Problem, die Transporte zur Erfuellung der anstehenden Lieferwuensche der Kunden zu disponieren. Dieses Geschaeftsmodell ist als Pilotprojekt derzeit auf den Großraum Berlin begrenzt. Im Rahmen des Beitrages wird zunaechst das der Praxis zugrundeliegende Tourenplanungsproblem beschrieben. Zur Loesung dieser praktischen Planungsaufgabe wird anschließend ein hybrider genetischer Algorithmus vorgestellt. Verschiedene Verfahrenskomponenten stellen sicher, daß die seitens der Praxis formulierten Anforderungen an Problemloesungen erfuellt werden. So wird die Berueckksichtigung der Belieferungsintervalle durch eine Problemdekomposition sichergestellt. Den Anforderungen externer Spediteure auf kostenguenstige Routen wird durch die Integration eines Branch-and-Bound-Verfahren erfuellt, welches entfernungsminimale Routen berechnet. Hierbei wird auf ein kommerzielles Entfernungswerk zurueckgegriffen, um Fahrzeiten und Entfernungen zwischen Kundenorten unter praktischen Gegebenheiten zu berechnen.

Den Abschluß des Beitrages bildet eine Verfahrensevaluation anhand der praktischen Probleminstanzen einer repraesentativen Referenzwoche. Ein Vergleich mit der bislang im Lieferservice verwendeten Planungsmethode zeigt, daß durch das entwickelte Verfahren die Auslieferungskosten um ca. 10% gesenkt werden konnten. Aufgrund der erzielten Ergebnisse wird das Verfahren in Zukunft im Lieferservice zur Transportdisposition eingesetzt.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 09 (see p. 49 for session)

Irnich, Stefan *(LuF Operations Research und Logistik Management, RWTH Aachen)*
Funke, Birger *(GTS Systems and Consulting GmbH, Herzogenrath)*
Grünert, Tore *(LuF Operations Research und Logistik Management, RWTH Aachen)*

Local Search for Vehicle Routing and Scheduling Problems (Part I): Neighborhoods

The talk presents a systematic classification and analysis of the different types of neighborhoods for *vehicle routing and scheduling problems* (VRSPs). VRSPs have in common that a fleet of vehicles have to serve a number of requests so that costs are minimized. We will focus on the node-routing version of the problem. Solving these types of problems to optimality is still an open challenge in the case of larger instances. Therefore, heuristics and metaheuristics which rely on local search (LS) are the methods of choice for solving larger instances.

LS methods are based on the definition of a problem-specific neighborhood. The neighborhood of a solution, i.e. of a route plan, consists of other route plans which are constructed from the given route plan by performing a *move*. We present a representation of VRSP solutions by the so-called *giant tour*. This representation is general enough to cover most practically relevant cases of VRPSs with complicated feasibility constraints, several depots, and heterogeneous fleets. Furthermore, it allows a precise definition of a (feasible) move and its decomposition into so-called partial moves. The deeper analysis of partial moves is advantageous to derive interesting insights into properties of moves like independence of its partial moves and the computation of partial gains. These aspects give rise to more effective search techniques discussed in the second part of the talk. We will apply the analysis to different types of neighborhoods, namely, node-exchange and edge-exchange neighborhoods as well as large-scale neighborhoods and partially constructive neighborhoods.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 09 (see p. 45 for session)

Kharraziha, Hamid *(Carmen Systems AB)*

Large Scale Crew-Rostering

Carmen Systems' crew rostering product is currently used by several major European airline and railway companies. In the largest problem that is solved today, around 7000 crew-members are assigned roughly 30000 tasks. Production quality rosters are produced within 14 hours of optimization time. In my talk, I will describe the sequence of algorithms that are applied and the way these have been modified and extended in order to cope with the largest problems.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 09 (see p. 45 for session)

Kliewer, Natalia *(Universität Paderborn)*
Gintner, Vitali *(Universität Paderborn)*

Mehrdepot-Umlaufplanung für ÖPNV-Betriebe

Bei der Bildung der Bus-Umläufe sollen alle Fahrten eines Betriebstages in disjunkte Teilmengen zerlegt werden, so dass die in jeweils einer dieser Teilmengen enthaltenen Fahrten von einem Fahrzeug nacheinander bewältigt werden können. Dabei sind die Gesamtkosten des Ressourceneinsatzes zu minimieren.

Weil jede Fahrplanfahrt von mehreren Depots und mit einigen bestimmten Fahrzeugtypen bedient werden kann, besitzt die Problemstellung eine hohe kombinatorische Komplexität. Der Nachteil bekannter Modellierungsansätze ist die explizite Berücksichtigung aller potentiellen Fahrtenverknüpfungen, deren Anzahl quadratisch mit der Anzahl der Fahrten wächst und die Modellgröße für praxisrelevante Probleminstanzen explodieren lässt. Um dies zu umgehen, wird in diesem Beitrag eine Time-Space-Netzwerk basierte Modellierung vewendet. Die Anzahl der Kanten im Time-Space-Netzwerk ist viel kleiner, die Menge der zulässigen Lösungen des Umlaufplanungsproblems bleibt aber weiterhin komplett. Somit kann man mit dem zweiten Ansatz optimale Lösungen für größere Probleminstanzen, als mit dem ersten erreichen. Die Vergleiche auf den Probleminstanzen realer ÖPNV-Unternehmen ergeben eine Reduktion von 97-99% in der Anzahl entsprechender Fahrtenverbindungs-Kanten.

In der Modellierung und Implementierung wurden zusätzlich einige Anforderungen berücksichtigt, die die berechnete Umlaufpläne praxistauglich machen. Im Rahmen einer Kooperation mit PTV AG ist eine Software-Komponente implementiert worden, die den ÖPNV-Planer bei der Erstellung der Busumläufe unterstützen soll. Mehrdepot-Probleminstanzen von zwei deutschen Großstädten mit mehreren Tausend Planfahrten wurden exakt optimal gelöst. Um die Lösungszeiten zu reduzieren, bzw. um Instanzen lösen zu können, die mit exakter Optimierung nicht in annehmbarer Zeit lösbar waren, wurde ein heuristisches Verfahren implementiert. Testläufe auf verschiedenen Instanzen weisen sehr gute Lösungsqualität auf.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 09 (see p. 53 for session)

Ladner, Klaus *(Karl-Franzens-Universität Graz)*

Suche einer Signalfolge einer Verkehrslichtsignalanlage mit Hilfe eines Zustands- /Schichtgraphen

Es wird ein Online-Algorithmus zur Steuerung von Verkehrslichtsignalanlagen entworfen, der abhängig von der gerade aktuellen Verkehrssituation unter Berücksichtigung der verkehrstechnischen Nebenbedingungen eine Grobplanung für den nächsten Umlauf erstellt.

Dabei werden die Bilder – das sind die möglichen und als sinnvoll betrachteten Kombinationen von Verkehrsströmen – als Zustände betrachtet. Der zeitliche Ablauf wird in Schichten klassifiziert.

In dem sich ergebenden Zustands- /Schichtgraphen fließen die Vorstellungen des Verkehrsplaners insoferne ein, als dass Zeitfenster definiert werden können, innerhalb derer Verkehrsströme entweder keinesfalls Grün haben dürfen oder unbedingt Grün haben müssen, um die Koordinierung mit den umliegenden Kreuzungen ermöglichen zu können.

Der Graph wird mit einer künstlichen Quelle und Senke erweitert, sodass ein Pfeilweg durch diesen gesucht werden kann, der die Summe der Knotenbewertungen maximiert. Die Problematik liegt darin, dass nicht alle Pfeile beliebig verwendet werden dürfen, sondern nur in Abhängigkeit des bisherigen Lösungsvektors entschieden werden muss, ob die Verwendung eines Pfeiles die Einhaltung der minimalen und maximalen Grün- und Rotzeiten einhält.

Da der Algorithmus auf einfachen Kreuzungsrechnern laufen soll, muss er extrem schnell und mit bescheidenem Speicheraufwand gute Ergebnisse liefern können.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 09 (see p. 53 for session)

Lindberg, Per Olov *(Department of Mathematics, Linköping University)*
Engelson, Leonid *(Inregia, Stockholm)*

Convexification of the Traffic Equilibrium Problem with Social Marginal Cost Tolls

In an earlier paper, we have demonstrated that traffic equilibria under social marginal cost tolls can be computed as local optima of a nonconvex optimization problem. The nonconvexity of this problem implies in particular that linearizations, e.g. in the Frank-Wolfe method, do not give underestimates of the optimal value.

In this talk we derive the convex hull of nonconvex arc cost functions of BPR type. These convexifications can be used to get underestimates of the optimal value, or to get better search directions in the initial phase of the Frank-Wolfe method.

Computational results for the Sioux Falls and Stockholm networks will be reported.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 09 (see p. 53 for session)

Mahalel, David *(Civil and Env. Engineering Transp. Research Institute, Technion Haifa)*

Behavioural Aspects at Signalized Intersections during the Intergreen Period

Intergreen period is the transition period at signalized intersections from the end of the green phase until the beginning of the following green phase. The change from one signal message to another (for example, from green to amber and then from amber to red) creates a decision problem (whether to stop or go) to drivers. An impropriate go decision might cause a right-angle or rear-end accident and an early stop decision might produce a rear-end decision.

This paper presents a disaggregate behavioural model which predicts the probability of stopping on the onset of amber light. Based on field data, the model enable to judge the quality of drivers' decisions at different traffic situations and different signal design. These situations include light and heavy traffic as well as short and long warning period by introducing flashing green light before the amber.

It was found that engineering design rules for determining the intergreen period are not based on driving behaviour and different rules should be considered. It was also found that the flashing green period increases the option zone and consequently the chances for rear-end collisions are increased.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 09 (see p. 42 for session)

Pankratz, Giselher *(FernUniversität in Hagen)*

A Genetic Algorithm Based Approach for Solving the Dynamic Pickup and Delivery Problem with Time Windows

The Dynamic Pickup and Delivery Problem with Time Windows (DPDPTW) is a dynamic generalization of the well studied Vehicle Routing Problem with Time Windows (VRPTW). Since it models several typical planning situations in operational transportation logistics and public transport, it is of great practical importance. This contribution proposes a two-level, Genetic Algorithm based approach for solving the DPDPTW. At the basic level, a Grouping Genetic Algorithm (GGA) is employed in order to solve static PDPTW instances. In contrast to the traditional Genetic Algorithm, the proposed GGA features a group-oriented genetic encoding in which each gene represents a group of requests instead of a single request. At the second level, the GGA is embedded in a dynamic planning environment which triggers the execution of the GGA each time the planning situation has changed, e.g. due to the arrival of new transportation requests. By this, the DPDPTW is decomposed in a rolling horizon fashion into a sequence of static PDPTW instances which in turn are solved by the GGA. Special synchronization and updating mechanisms are applied which allow the population of the GGA to be used as an adaptive memory. The solution approach is evaluated using a suite of DPDPTW instances with varying dynamic properties. The problem instances were derived from publicly available benchmark data sets for the (static) PDPTW. The results obtained seem to justify the proposed dynamic solution approach.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 09 (see p. 56 for session)

Pfetsch, Marc *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Borndörfer, Ralf *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Grötschel, Martin *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*

Strategic Planning in Public Transport

We discuss the applicability of mathematical optimization in the field of strategic planning in public transport. The goal is to extend the success story of applications of mathematical optimization in the field of operational planning, e.g., vehicle routing and crew scheduling. It seems reasonable to divide the strategic planning process for public transport into the following problems: network design, line planning, frequency planning, and computing the schedule. Apart from these, the planning of fares should be considered.

Much less research has been devoted to these problems, compared to the problems appearing in operational planning. We will present mathematical optimization models for each of these problems, except schedule computation, and discuss solution approaches. The models are in part based on integer programming approaches and in part on nonlinear constraint (integer) programs.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 09 (see p. 38 for session)

Reents, Gerriet *(Universität Oldenburg)*

Vermittlung von Fahrgemeinschaften betrachtet als Vehicle Routing Problem

Ein Weg den Berufspendelverkehr zu reduzieren, ist die verstärkt Bildung von Fahrgemeinschaften. Zu diesem Zweck

wurde an der Universität Oldenburg ein automatisches, internet-basiertes Vermittlungssystem für Fahrgemeinschaften entwickelt, das die bestehenden Informationsdefizite und Kommunikationshemmnisse verringern soll. Dieses System, genannt ORISS, wird ab Mitte 2003 einen Probebetrieb aufnehmen. ORISS erlaubt es Nutzern ihre Anfragen mit vielen Details z.B. durch die Angabe von Start- und Zielorten mittels Strasse und Hausnummer und von minutengenauen Abfahrts- und Ankuftszeitfenstern zu beschreiben. Auf der Konferenz OR2001 in Duisburg wurde die Modellierung des Vermittlungsproblems innerhalb von ORISS als spezielles Vehicle Routing Problem (VRP) mit Kapazitäten, Zeitfenstern, Reihenfolgen sowie weiteren problemspezifischen Eigenschaften bereits vorgestellt. Basierend hierauf wurden zwei Heuristiken sowie ein exakter Algorithmus entwickelt. Die eine Heuristik verwendet einen Greedy-Ansatz. Die andere Heuristik ist nach dem Prinzip der Tabu Suche konstruiert. Wegen der begrenzten Rechenzeit werden im Praxisbetrieb die beiden Heuristiken und nicht der exakte Algorithmus verwendet. Dieser wurde unter anderem zur Einschätzung der Qualität der Heuristiken entwickelt. Im Bereich der VRP haben sich Lösungsansätze, die auf Dekompositionstechniken beruhen, als erfolgreich herausgestellt. Daher wird hier das Branch&Price-Konzept verwendet. Dabei findet eine Dekomposition in ein Master- und ein Pricing-Problem statt. Das Master-Problem besteht aus der optimalen Auswahl aus einem Pool von möglichen Fahrgemeinschaften. Im Rahmen des Pricing-Problems wird eine Fahrgemeinschaft gesucht, die die aktuelle Lösung des Master-Problems weiter verbessern kann. Im Vortrag werden die entwickelten Verfahren vorgestellt und ein Vergleich anhand künstlich generierter, jedoch realitätsnaher Testfälle gegeben.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 09 (see p. 49 for session)

Reimann, Marc *(Universität Wien)*

Using MST Information for Solving the TSP with an Ant System

This talk will focus on the proposition and evaluation of different ways to hybridise exact with meta-heuristic algorithms for NP hard combinatorial optimisation problems. More precisely, information obtained from applying exact algorithms to polynomially solvable problem relaxations will be used in the context of an Ant System for the original problem.

The benchmark problem considered for illustration of the approach is the symmetric TSP. The problem relaxation chosen is the Minimum Spanning Tree (or the 1-Tree). Three different ways to incorporate the information contained in the exact solution to the MST problem are evaluated. First, the pheromone information is initialised with the information about the minimal spanning tree. Second, a higher heuristic weight is assigned to the edges that are part of the minimal spanning tree. Third, the Ant System uses the minimal spanning tree as an initial solution and transforms this initial solution into a feasible TSP tour.

Clearly these three alternatives differ with respect to the extent of hybridisation. Thus, the contribution of a more involved usage of MST information is analysed. Moreover, the results obtained are compared with results from other Ant System approaches for the TSP and with the known optimal solutions. This analysis shows that the proposed approach outperforms other AS algorithms significantly.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 09 (see p. 42 for session)

Reinholz, Andreas *(University Dortmund)*

Iterated Local Search, Variable Neighborhood Search and Hybrid Evolutionary Algorithms for Periodic Multiple Depot Vehicle Routing Problems

The Periodic Multiple Depot Vehicle Routing Problem (PMDVRP) can be viewed as a four level hierarchy of decision and optimization tasks that invokes the Traveling Salesperson Problem (TSP), the Set Partitioning Problem (SPP), the Capacitated Vehicle Routing Problem (CVRP), the Multiple Depot Vehicle Routing Problem (MDVRP), the Periodic Traveling Salesperson Problem (PTSP) and the Periodic Vehicle Routing Problem (PVRP) as sub problems.

In this talk a standardized methodology will be presented which was used to develop several operators, Neighborhood Search (NS), Iterated Local Search (ILS), Variable Neighborhood Search (VNS) and Hybrid Evolutionary Algorithms (Hybrid-EA) for all the problems mentioned above. One aim of the standardizes methodology is to start with a quick and easy implementation that could be improved step by step by refinement and adding more complex and powerful elements and procedures.

To show the development of competitive solvers for the PMDVRP and its sub problems, I will introduce problem specific operators which are working on different levels of the problem hierarchy, trying to transform valid solutions to valid solutions, using problem specific coding, efficient data structures and accelerated evaluation methods of the objective function.

Please note, that this standardized methodology was used to implement solvers that were applied very successful to the integer and real number Instances of the mainstream benchmarks of the CVRP, MDVRP, PTSP and PVRP. For all considered 182 instances the quality of the new computed solutions were at least as good as the best solutions published so far. For 102 instances new best solutions with improvement up to 3.48% could be found.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 09 (see p. 38 for session)

Schönberger, Jörn *(Chair of Logistics, University of Bremen)*
Kopfer, Herbert *(Chair of Logistics, University of Bremen)*

Combined Request Selection and Transport Planning – Models and Algorithms

Vehicle routing problems have their origins in distribution and/or collection problems. Typically, a sufficient large fleet of vehicles is exclusively available for fulfilling the transport tasks (requests).

In the last two decades, a large number of companies sourced out the fleets into independent carrier companies and allowed them to operate for their own responsibility. For such a carrier, the operational short-term route generation problems differ considerably from the standard models: VRP, VRPTW, PDP or PDPTW. These differences include:

Scarce Resources: Since the daily request portfolio cannot be anticipated exactly and since the available transport resources cannot be adapted to the needed demand, bottleneck-situations occur in which the demanded transport resources exceed the available capacities. For this reason, a selection of requests is necessary.

Compulsory Requests: The request selection is compromised by unrejectable (compulsory) requests, specified in middle- or long-term contracts. Their service cannot be refused. Additional ad-hoc requests are allowed to be served as long as all compulsory requests are fulfilled as contracted.

Maximizing profits: The maximization of the profit contribution (gained revenues minus spent costs) is desired instead of minimizing the travel costs.

We extend the PDPTW by these requirements in order to provide planning models for integrated request selection and route determination scenarios. The resulting combinatorial optimization models are combined request selection, request assignment and visit sequencing models. Capacity constraints and customer specified time windows further compromise the composition of requests into profitable routes.

To solve instances of these combined request selection and routing problems, we propose the application of a Memetic Algorithm toolbox, which has been developed for solving instances of this problem class.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 53 for session)

Steinbach, Marc *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Gnädig, Bernd *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*

Operative Planning in Drinking Water Supply: A Case Study

The lecture presents results of a case study aiming at minimum-cost operative planning of Berlin's drinking water supply over an optimization horizon of 24 hours and under the assumption of reliable demand forecasts. Basis of the study was a nonlinear dynamic network model developed by Berliner Wasserbetriebe and covering their waterworks, pump stations, storage tanks, and major pipes; that model was implemented and solved within GAMS. We discuss the experience gained from computational experiments with different variants of the model and different optimization algorithms, addressing in particular modeling issues, convergence enhancement techniques, solution properties, and practical aspects.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 09 (see p. 56 for session)

Zimmermann, Uwe *(Technical University Braunschweig)*

Optimal Shunting

Cost for shunting are rather expensive. How to reduce these efforts to the absolute necessary amount? Nice mathematical modells lead to various easy and hard combinatorial optimization problems. On the other hand, shunting occurs as one part of more complex railway problems in public and industrial transportation. We report about MIP models, solved and open mathematical problems as well as experience in related practical projects.

4.5 Section 5: Scheduling and Project Management

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 01 (see p. 50 for session)

Ageev, Alexander A. *(Sobolev Inst. of Mathematics, Novosibirsk)*
Baburin, Alexei Y. *(Novosibirsk State University, Novosibirsk)*

Approximation Algorithms for Single and Two-Machine Flow Shop Problems with Exact Delays

We consider the single- and two-machine flow shop scheduling problems with exact delays. In both problems a set $J = \{1, \ldots, n\}$ of n independent jobs is given. Each job j consists of two operations with an intermediate delay l_j: the second operation of job j starts exactly in l_j time units after the completion of the first operation. In the single-machine problem all operations are executed by a single machine M. In the two-machine flow shop problem the first operations are executed by a machine M_1 and the second ones by a different machine M_2. As usual, it is assumed that at any time no machine can process more than one operation and no preemptions are allowed in processing of any operation. Processing the first (second) operation of job j takes time p_{1j} (p_{2j}). The objective is to minimize the makespan (the schedule length).

The two-machine flow shop problem with minimum delays (where the second operation of job j can start in at least l_j time units after the completion of the first operation) was studied as early as in classical works of Johnson and Mitten (1958). Orman and Potts (1997) studied the problem of minimizing the idle time of a radar, which they formulated as a single-machine problem with exact rather than minimum delays. Yu (1996) proved that both two-machine (and hence single-machine) problems are strongly NP-hard in the case of unit processing times. Dell'Amico (1996) suggested a 2-approximation algorithm for the two-machine flow shop problem with minimum delays. Strusevich (1999) designed a $3/2$-approximation algorithm for the open shop version of this problem.

In this work under the assumptions of unit processing times we design $7/4$- and $3/2$-approximation algorithms for the single-machine and two-machines problems with exact delays respectively.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 50 for session)

Ahuja, André *(Lehrstuhl für BWL, insb. OR, FernUniversität Hagen)*

Risiko- und Konfliktmanagement im IT-Projekt

Die Notwendigkeit von projektbegleitendem Risiko- und Konfliktmanagement sind der Preis für die Anwendung vereinfachender, deterministischer Partialmodelle auf eine komplexe unternehmerische Problemstellung, welches das Projekt definitionsgemäß ist. Solche Teilmodelle sind insbesondere zur Planung von IT-Projekten deshalb nur eingeschränkt geeignet, weil hier die Erstellung eines immateriellen Gutes auf Grundlage von in Verträgen zwischen mehreren Beteiligten formulierten Qualitätsanforderungen verfolgt wird. In Konsequenz mangelt es typischerweise etwa an einer hinreichend genauen Leistungsbeschreibung zum Zeitpunkt des Vertragsabschlusses. Stehen Art und Weise der Modellierung nicht zur Disposition, so sollte unter den umrissenen Randbedingungen zumindest die Ausgestaltung von Konflikt- und Risikomanagement auf die besonderen Charakteristika und Anforderungen des IT-Projekts abgestimmt werden. In dieser Arbeit wird ein allgemeines Strukturmodell für die Projektsituation aufgebaut. Danach wird in diesem Modell der Fokus auf das IT-Projekt gelegt: Die gemäß oben benötigten Beschreibungsmerkmale sind hiermit gefasst. Dies ausnutzend lässt sich eine signifikante Einschränkung des grundlegenden Instrumentariums zur Lösung operativer Projektkonflikte nun für das IT-Projekt vornehmen, und es zeigt sich, dass der Handlungsspielraum zur Konfliktbehebung prinzipiell wesentlich enger als beispielsweise im industrieellen Entwicklungsprojekt ist. Da Risikomanagement präventives Konfliktmanagement ist, übertragen sich die gewonnenen Erkenntnisse auf die probate Wahl von Werkzeugen für die Phase der Risikoidentifikation. Abschließend werden, auch motiviert durch den aktuellen Forschungsschwerpunkt des Autors, die Zusammenhänge als implementiertes Expertensystem für die zweite Phase des Risikomanagementprozesses, nämlich die Risikoanalyse, herangezogen.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 01 (see p. 38 for session)

Brucker, Peter *(Universität Osnabrück)*
Strotmann, Christian *(Universität Osnabrück)*

Decomposition of Railway Scheduling Problems

Railway scheduling problems can be modeled as generalized job-shop problems. This leads to the concept of directed networks with additional pairs of alternative arcs which generalizes the disjunctive graph model. One has to choose from each pair one arc such that the network together with the chosen arcs contains no positive cycle. Whithin such a framework the decomposition of a large railway network into subnetworks and a coordination network is discussed. Local search methods for solving the problem are presented which are based on such a decomposition.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 50 for session)

Buchholz, Jens *(University Duisburg-Essen)*
Schultz, Rüdiger *(University Duisburg-Essen)*

Optimal Machine Scheduling in a Shipyard

The talk deals with real-life machine scheduling in the manufacturing unit of a major german shipyard. Standard problems are often strongly influenced by additional restrictions which arise from the application. In this case the standard job shop scheduling problem is modified due to the fact that we have a machinery consisting of several machine groups with identical machines. Furthermore the solution has to fulfil a given shift schedule. The shift schedule can differ from machine group to machine group. The optimization goal is non-standard, too. We are heading for a schedule including as many jobs completed in due time as possible. We present a linear mixed integer model for the described problem. Moreover we report first computational experience with real data and compare our results with schedules obtained by an in-house heuristic of the shipyard.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 45 for session)

Ehrgott, Matthias *(Department of Engineering Science, University of Auckland)*
Ryan, David M. *(Department of Engineering Science, University of Auckland)*

Optimization of Cost and Robustness in Airline Crew Scheduling

Optimisation based computer systems are used by many airlines to solve crew planning problems by constructing minimal cost tours of duty. However, today airlines do not only require cost effective solutions, but are also very interested in robust solutions. A robust solution is understood to be one where disruptions in the schedule (due to delays) are less likely to be propagated into the future, causing delays of subsequent flights.

These considerations lead to a multiobjective framework, as the maximisation of robustness will be in conflict with the minimisation of cost. For example crew changing aircraft within a duty period is discouraged if inadequate ground time is provided. We develop a bicriteria optimisation framework to generate Pareto optimal schedules for a domestic airline.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 01 (see p. 38 for session)

Elendner, Thomas *(University of Kiel)*

A Lagrangean Heuristic for the Weighted Job Interval Scheduling Problem

In our talk we consider the problem where positive–weighted jobs with specific release and due dates compete for time–slots on a single machine with the assumption, that not all jobs can be scheduled. Since the so–called "Weighted Job Interval Scheduling Problem" (WJISP) is known to be $\mathcal{NP}$–hard, heuristics have become a main research interest. Unfortunately, there has not been done much research on upper bounds so far. Furthermore, to the best of our knowledge, no runtime studies are available in the literature yet. Here, we try to close these gaps. We present a Lagrangean heuristic for the WJISP and characterize test instances. Using this test–bed, the considered upper and lower bounds are respectively compared to the LP–solution and to a heuristic taken from the literature.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 01 (see p. 42 for session)

Fernando Gonçalves, José *(Faculdade de Economia da Universidade do Porto)*
Magalhães Mendes, Jorge *(Instituto Politécnico do Porto - Instituto Superior de Engenharia)*

A Random Key Based Genetic Algorithm for the Resource Constrained Project Scheduling Problem

This paper presents a genetic algorithm for the Resource Constrained Project Scheduling Problem RCPSP. The chromosome representation of the problem is based on random keys. The schedule is constructed using a heuristic priority rule in which the priorities of the activities are defined by genetic algorithm. The heuristic generates parameterized active schedules. The algorithm is tested on a set of standard problems taken from the literature and compared with other approaches. The computation results validate the effectiveness of the proposed algorithm.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 01 (see p. 46 for session)

Gordon, Valery *(United Inst. of Informatics Problems, Nat. Academy of Sciences of Belarus, Minsk)*
Proth, Jean-Marie *(INRIA-Lorraine, Metz)*
Strusevich, Vitaly *(University of Greenwich, London)*

Single Machine Scheduling with Precedence Constraints and Due Date Assignment

We consider a single machine due date assignment and scheduling problem of minimizing holding costs with no tardy jobs under precedence constraints. The due dates of the jobs are assigned according to the SLK rule, i.e., using an additive slack with respect to the processing times. The objective function is an arbitrary non-decreasing function that depends on the slack and on a function F, which is either the total weighted earliness or the total weighted exponential earliness. A general scheme for solving this problem has been developed by Gordon and Strusevich (1999). In particular, it has been shown that in the case of the series-parallel precedence constraints the optimal slack and the corresponding optimal schedule can be found in polynomial time. In this presentation, we extend that approach to the precedence graphs that admit modular decomposition of a fixed width w. The running time of the resulting algorithms does not exceed $O(n^{w+2})$.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 01 (see p. 57 for session)

Guigues, Vincent *(LMC IMAG, Grenoble)*

Application of Robust Counterpart Technique to Production Management

The problem of production management can be often cast in the form of linear program with uncertain parameters and risk constraints. Typically, such problems are treated in the framework of multi-step Stochastic Programming. Recently, a new Robust Counterpart (RC) approach has been proposed in the literature, in which the decisions are optimized for the worst realizations of problem parameters. However, an application of the RC technique often results in very conservative approximations of uncertain problems. To tackle this drawback, an Adjustable Robust Counterpart (ARC) approach has been proposed in [1]. In ARC, some decision variables are allowed to depend on past (and thus available at the moment when decision is made) values of uncertain parameters. A restricted version of ARC, introduced in [1], which can be efficiently solved, is referred to as Affinely Adjustable Robust Counterpart (AARC). The implementation of robust programs relies on the description of parameter uncertainty sets, which can be defined using the a priori information and/or available past observations of problem parameters.

In this paper, we consider an application of RC and AARC methodology to the problem of annual electricity production management and gas distribution management in France. We compare the quality of robust solutions obtained by polyhedral or ellipsoidal uncertainty sets which are estimated using historical data.

[1] Ben-Tal, Goryashko, Guslitzer, Nemirovski. Adjustable Robust Solutions of Uncertain Linear Programs.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 01 (see p. 57 for session)

Jana, R. K. *(Department of Mathematics, Indian Institute of Technology, Kharagpur)*
Biswal, M. P. *(Department of Mathematics, Indian Institute of Technology, Kharagpur)*

A Multi-Product Production Repair Model and its Solution using Hybrid Algorithms

This paper deals with a stochastic production repair model with chance constraints. A solution to such problems has great importance to the managers because such a solution serves as an invaluable tool for them in the process of developing a production plan to their companies. The common way of tackling such a problem is to derive the crisp equivalent of the original problem. This is possible if the parameters involved in the chance constraint follow some specific distribution or if we can estimate/approximate the chance constraints using some estimation procedure or using some numerical technique. In this paper, we propose a multi-product, single period and single plant chance constraint programming model having production and repair work simultaneously with no restrictions on the stochastic parameters. To solve the mathematical model, we have developed two hybrid algorithms. The first algorithm is a stochastic simulation based genetic algorithm and the second algorithm is a stochastic simulation, neural network and genetic algorithm based hybrid algorithm. These algorithms can deal the stochastic parameters having any possible distribution. Finally, a numerical example is presented on the basis of data collected from an industry. We solve the numerical example using both the algorithms and compare the results.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 01 (see p. 53 for session)

Janiak, Adam *(Wroclaw University of Technology)*
Kozik, Andrzej *(Wroclaw University of Technology)*

Scheduling Jobs with Time and Resource Dependent Processing Times

The paper deals with problems of scheduling jobs, where job processing times depend on the start time of their execution

and on the amount of discretely divisible resources allocated to them. A solution of a problem for a given optimization criterion is represented by a job sequence and a resource allocation vector. We consider problems of scheduling jobs on a single machine and on parallel identical machines. We concern two optimization criteria: minimization of the makespan and minimization of the total completion time, both subject to a given constraint on the total amount of allocated resources. We present some properties of the optimal solution for the considered problems based on which we construct optimal and near-optimal solutions to them.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 01 (see p. 46 for session)

Kanet, John *(University of Dayton)*

Precedence Theorems for One-Machine Weighted Tardiness

In an earlier paper by Emmons (1969), the problem of sequencing jobs on a single machine in order to minimize total tardiness was analyzed. Emmons provided three theorems for specifying precedence relations for pairs of jobs. His theorems apply when the tardiness penalty for each job grows at the same rate. Rinnooy Kan, Lageweg, and Lenstra (1975) later extended Emmons's theorems to the case when job tardiness penalties can grow at different rates for different jobs. Presented here is a set of stronger theorems than those of Rinnooy Kan, et al., which more fully exploit the special properties of the weighted tardiness function.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 01 (see p. 50 for session)

Knust, Sigrid *(Universität Osnabrück)*
Brucker, Peter *(Universität Osnabrück)*
Wang, Guoqing *(Jinan University Guangzhou)*

Complexity Results for Flow-Shop Problems with a Single Server

Flow-shop problems with a single server are generalizations of classical flow-shop problems and can be formulated as follows. We are given m machines $M_1, \ldots, M_m$ and n jobs $j = 1, \ldots, n$. Each job j consists of m operations O_{ij} $(i = 1, \ldots, m)$ which have to be processed in the order $O_{1j} \rightarrow O_{2j} \rightarrow \ldots \rightarrow O_{mj}$. Operation O_{ij} has to be processed on machine M_i without preemption for $p_{ij} \geq 0$ time units. Each machine can only process one operation at a time. Immediately before processing an operation O_{ij}, the corresponding machine has to be prepared, which takes a setup time of s_{ij} time units. During such a setup the machine is also occupied for s_{ij} time units, i.e. no other job can be processed on it. The setup times are assumed to be separable from the processing times, i.e. a setup on a subsequent machine may be performed while the job is still processed on the preceding machine. All setups have to be done by a single server which can perform at most one setup at a time. The goal is to determine a feasible schedule which minimizes a given objective function. Such a situation may occur in practice when in addition to a machine different tools are needed for processing the operations. One server is responsible for preparing the machine with the required tool which takes a certain setup time.

New complexity results are derived for special cases.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 01 (see p. 42 for session)

Kolisch, Rainer *(Technical University München)*
Meyer, Konrad *(Technical University Darmstadt)*

Central vs. Decentral Scheduling of Research Projects

The problem treated is the scheduling of a number of research projects subject to scarce resources such that the amount of weighted work accomplished within a give time frame is maximized. The problem arises in the field of pharmaceutical research. We consider two solution approaches: The central method derives a detailed schedule for all activities of the projects. The dentral method derives aggregated priority values for the projects. Based on these values scheduling is performed by the individual resources. We compare both methods in terms of the quality of solutions and the computational as well as the organizational effort.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 01 (see p. 38 for session)

Kotov, Vladimir *(DMA Department, Belarusian State University, Minsk)*
Cheng, T.C. Edwin *(Department of management, The Hong Kong Polytechnic University)*
Kellerer, Hans *(University of Graz)*

Semi On-Line Problems on Identical Machines

We are given a set of identical machines and a sequence of jobs. The jobs are to be assigned on-line to one of the

machine and the objective is to minimize the makespan. We investigate some semi on-line versions of the problem when sum of jobs weights is known in advance or jobs appear in decreasing order. Algorithms with performance bounds 1.6 and 1.263 are presented.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 01 (see p. 50 for session)

Kovalyov, Mikhail Y. *(Belarus State University, Minsk)*
Ng, C.-T. Daniel *(The Hong Kong Polytechnic University)*

Scheduling Two-Machine Flowshop with one Inavailability Interval

We study a deterministic two-machine flowshop scheduling problem with an assumption that one of the two machines is not available in a specified time period. This period can be due to a breakdown, preventive maintenance or processing unfinished jobs from a previous planning horizon. The problem is known to be NP-hard. Pseudopolynomial dynamic programming algorithms and heuristics with worst case error bounds are given in the literature to solve the problem. They are different for the cases when the unavailability interval is for the first or second machine. The existence of a fully polynomial time approximation scheme (FPTAS) was formulated as an open conjecture in the literature. In this paper, we show that the two cases of the problem under study are equivalent to similar partition type problems. Then we derive a generic FPTAS for the latter problems with $O(n^5/\varepsilon^4)$ time complexity.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 01 (see p. 46 for session)

Krysiak, Tomasz *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Janiak, Adam *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Wajs, Wieslaw *(Department of Automatics, University of Mining and Metallurgy, Krakow)*

A Single Processor Scheduling Problem with a Range-Linear Model of Loss of Job Value

The paper deals with a problem of scheduling jobs on a single processor in order to minimize the sum of losses of job values. The model of the loss of job value is described by a range-linear function of the time. It means that the function domain is divided into two or more ranges at which the function is linear and non-decreasing.

This problem can be applicable in financial area when we want to pay several diverse loans with variable interest rates. Namely, assume that the length of repayment period for each of these loans is determined at the reaching of agreement, and the height of interest depends on this length (for example: when we repay a loan within 3 months we have to pay 4.5% of interest and when we repay this loan within more than 3 months we have to pay 5%). Thus, an amount of money, which we have to spend in order to repay each loan, increases if the length of loan repayment period lengthen. The increase of the amount of money mentioned above for each loan can be described by non-decreasing range-linear function of the time. Suppose that, due to limited financial resources, we are able to pay only one loan at the moment. Thus, the problem is to find such an order of paying all the loans that the sum of the amounts of money spent to repay these loans is minimal.

A special case of this problem – with only two ranges of linear function for each job – is considered in the paper. It is shown that the problem is strongly NP-hard. Several properties, which are helpful to solve the problem, are also shown. Moreover, in order to solve the general version of the problem under consideration, we constructed and experimentally tested several heuristic algorithms.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 01 (see p. 53 for session)

Lichtenstein, Maciej *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Janiak, Adam *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*

Optimal Resource Distribution in Scheduling Problems with Resource Dependent Setup and Processing Times

In the classical scheduling theory it is assumed that all the problem parameters, such as job processing times, release dates, setup times, etc. are some a priori given, fixed values. In many practical applications, however, those parameters can be compressed (i.e. shortened) through the consumption of some additional resources such as energy, financial outlay, catalyzer, etc. Thus, the problems in which some their parameters are dependent on additional resources have attracted great attention of the researchers over several recent years. This is motivated, beside obvious theoretical significance, by many practical applications which can be found in production processes and computer systems.

This paper is devoted to scheduling problems in which job processing times and setup times are dependent on some additional resources. The considered problems are either single machine as well as parallel machine with various models of job processing times and setup times. Commonly used scheduling criteria, such as makespan, maximum lateness, total weighted completion time, etc are taken into account. For each of considered problems its mathematical model is presented and the computational complexity is provided. For many cases polynomial time algorithms of optimal

distribution of limited resources are developed. Additionally, for problems that are proved to be NP-hard approximation algorithms are proposed and their efficiencies are verified experimentally. Real life example of application of proposed models is presented.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 50 for session)

Machowiak, Maciej *(Poznan University of Technology)*

Preemptable Malleable Tasks Scheduling Problem

The problem of optimal scheduling n independent tasks in a parallel processor system is studied. The tasks are malleable, i.e., a task may be executed by several processors simultaneously and the processing speed of a task is a non-decreasing function of the number of processors allotted to it. The total number of processors is m, and it is an upper bound on the number of processors that can be used by all the tasks simultaneously. It is assumed that the tasks are preemptable and the number of processors allotted to the same task may change during its execution. The objective is to find a task schedule and a processor allocation such that the overall task completion time, i.e., the makespan, is minimized. The problem is motivated by real-life applications of parallel computer systems in scientific computing of highly parallelizable tasks.

First, a relaxed problem, in which the number of processors allotted to each task is not required to be integer, is solved in $O(n \cdot \max\{m, n \cdot \log^2 m\})$ time. Furthermore, it is proved that the minimum makespan values for the original and relaxed problems coincide. I present a rectangle packing algorithm, which converts an optimal solution for the relaxed problem into an optimal solution for the original problem in linear time.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 45 for session)

Mattfeld, Dirk Christian *(University of Bremen)*
Branke, Jürgen *(University of Karlsruhe)*

Task Scheduling under Gang Constraints

Short term manpower planning determines a structure for the employment of personnel. We model such a problem as a multi-mode task scheduling problem with time windows and pairwise precedence constraints among tasks. We aim at determining a gang structure for the entire planning horizon that supports reliable as well as efficient operations. In our approach neither the number gangs nor their manning level are restricted in any way. We propose a tabu search procedure that moves tasks between gangs. In order to determine the manpower demand of each individual gang we solve the corresponding one-machine scheduling problem by an iterated Schrage-heuristic. Since this heuristic is computationally burdensome, we develop an approximation scheme for the insertion and the removal of a task from a gang and into a gang respectively. The approximation scheme is used to select a hopefully favorable move to be carried out. Computational experiments show the validity of our approach.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 01 (see p. 53 for session)

Mönch, Lars *(Institut für Wirtschaftsinformatik, Technische Universität Ilmenau)*
Schmidt, Jeannine *(Institut für Wirtschaftsinformatik, Technische Universität Ilmenau)*
Balasubramanian, Hari *(Arizona State University, Department of Industrial Engineering, Tempe)*
Fowler, John *(Arizona State University, Department of Industrial Engineering, Tempe)*

A Decision Theory Approach for Scheduling Jobs with Unequal Ready Times and Incompatible Families on a Single Batch Processing Machine

We present a method to solve a scheduling problem with incompatible job families and unequal ready times of the jobs for a single batch processing machine. Problems of this type arise, for example, in the diffusion process in semiconductor manufacturing and have great practical relevance. In the presence of unequal ready times of the jobs it is sometimes advantageous to form a non full batch; in other situations it is a better strategy to wait for future job arrivals in order to increase the fullness of the batch, i.e., allow for delayed schedules. We are interested in minimizing the performance measure total weighted tardiness (TWT). We extend the decision theory approach of Kanet and Zhou to the present situation. By introducing an appropriate time window, we first form a potential batch from the jobs that are ready within the time window. We then evaluate this decision by considering the TWT value of the remaining jobs. In order to calculate the TWT of these jobs we have to estimate the completion times of the jobs. We use a simple average completion time estimate and more sophisticated completion time estimate by a deterministic forward simulation using a variant of the Apparent Tardiness Cost Dispatching rule. We report on computational experiments based on generated test data.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 01 (see p. 50 for session)

Pawlak, Grzegorz *(Institute of Computing Science, Poznan University of Technology)*

Scheduling Tasks in a Two Machines Flow Shop with Transportation

In the paper the simulation model of two machines flow shop system with a single robot has been considered. The production system consists of turning and milling machines with buffers and transportation system formed by a single robot. Each machine contains a local tools charger with several different tools. The robot movement is linear and bi-directional. The really existing two machines flexible manufacturing system was modeled in the software simulation package SARA. The scheduling tasks problem in such a system in NP-hard. In the paper the simulation and modeling technique for the production systems was presented. The simulation technique was applied to find the tasks schedule with additional resource constraints.

Some simple algorithms have been implemented and computational experiments have been performed. In the model several criteria has been measured and statistics analyzed.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 01 (see p. 42 for session)

Soukhikh, Sergey *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

Tabu Search Algorithm for the Resource Constrained Project Scheduling Problem with Profit Reinvestment

The Resource Constrained Project Scheduling Problem with Profit Reinvestment is considered. There is an accumulative resource – financial. The Reinvestment of the Profit means that the financial resource may not be consumed but it also may be reproduced while processing the activities. This profit can be used for performance other activities. Since construction or investment projects have rather long-time planning horizon, it is appropriate to use Net Present Value (NPV) of the cash flows as performance criterion.

Each activity is defined by a processing time and a stream of deterministic cash flows, which is representing by the vector of payments. The financial resource for processing these activities is given. The dependence of activities is assigned by a partial order of their performance. The objective is to schedule the activities to maximize the Net Present Value of the project subject to the precedence and financial resource constraints. This problem is NP-hard in the strong case.

We propose a metaheuristic algorithm that consists of two-stage tabu search. The first stage (initial tabu search) generates a feasible and acceptably good solution, and the second stage (main tabu search) tries to search the solution space to improve the schedule obtained by the first stage. We use several types of neighbourhoods: linear and quadratic. The second stage is repeated until no more improvement is possible. Then, the procedure returns to the first stage and the same procedure is repeated. One execution of the first and second stages is called a pass, and the algorithm repeats a certain number of passes until we obtain a satisfactory solution. In order to examine the effectiveness of the proposed algorithm, we perform computational experiments.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 16 (Senatssaal) (see p. 45 for session)

Stark, Christoph *(Institut für Wirtschaftswissenschaften, Technische Universität Clausthal)*
Zimmermann, Jürgen *(Institut für Wirtschaftswissenschaften, Technische Universität Clausthal)*

Scheduling Regular and Temporary Employees with Qualifications in a Casino

Service industries are usually characterized by high personnel expenses as well as varying demands. Varying demands together with the fact that services cannot be stored lead to an ever–changing labor utilization over time. Since employees cannot be hired or laid off easily in the short–term, peaks in the labor utilization have to be absorbed by temporary personnel or flexible work schedules. Scheduling a workforce in this context hence constitutes a planning problem of high complexity.

In this paper we consider a days–off scheduling problem that arises when scheduling employees in a casino. Given a set of shifts of different lengths for each day of the planning horizon, we have to find a schedule for each employee that specifies his working days as well as a specific shift. Employees are characterized by qualifications necessary to fulfil certain tasks. Moreover, we discern between regular employees, that have to be assigned a predefined number of working hours, and temporary employees, which may be additionally employed in busy periods.

We consider two different methods, one exact and one heuristic, in order to compute solutions that ensure the consistency of an employee's qualifications with the qualifications required for the tasks he is assigned to. In order to obtain an exact solution, the problem is modelled as a minimum–cost multi–commodity network flow model, which can be solved by means of column generation and branch–and–bound procedures. Alternatively, good heuristic solutions are obtained by successively solving several assignment problems that are modelled as bipartite networks. The arc weights of such a network depend on qualifications, previously obtained solutions, and future events that are known beforehand. We will show how both methods can be adapted towards different practical objectives.

Finally, the methods proposed in this paper are compared and their advantages as well as disadvantages are discussed in detail.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 01 (see p. 57 for session)

Tran, Van Hoai *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*
Reinelt, Gerhard *(Institute of Computer Science, University of Heidelberg)*
Bock, Hans Georg *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*

A Parallel Approach to the Pricing Step in Crew Scheduling Problems

Crew Scheduling Problems are often solved by the Column Generation method in the framework of Branch and Price. The main idea of the method has two basic steps: (1) solving the linear problem for a subset of variables, (2) pricing out new variables with negative reduced costs. In the crew scheduling problem the pricing problem is NP-hard and takes about more than 90 per cent of the whole computation time. This is verified in all of our experiments as well as in papers of other authors. Therefore it is critical to improve the performance of this step. This paper will discuss an approach of using a cluster of computers to solve the problem. Several aspects of parallelizing the pricing step will be investigated in order to obtain a good speedup in solving randomly generated crew scheduling problems. The parallel methods are implemented in such a way that they facilitate future extensions and generalizations.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 16 (Senatssaal) (see p. 50 for session)

Wang, Chia-Li *(National Dong Hwa University, Hualien)*

Efficient Simulation of Queues in Heavy Traffic

For simulations of $GI/G/1$ queues, we compare the efficiency of estimators of moments of stationary delay D, including standard regenerative estimators, called DD, that are notoriously inefficient in heavy traffic. A method we call DI estimates moments of D from estimated moments of idle period I is much more efficient than DD in heavy traffic. In this talk, we show how to generate a sequence of realized values of the equilibrium idle period, I_e, and use it to construct new estimators of delay moments, called DE here. When arrivals are irregular, DE is much more efficient than DI by a factor of 20 in some runs, independent (or weakly dependent) of the traffic intensity and the service distribution. Comparing DE with DD, these factors multiply.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 01 (see p. 42 for session)

Wolf, Andreas *(Inst. f. Unternehmungsführung u. Unternehmensforschung, Univ. Bochum)*
Werners, Brigitte *(Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum)*

Dynamische Projektsteuerung unter Berücksichtigung der Risikoeinstellung der Projektleitung

Ziel einer kostenorientierten Projektplanung und -steuerung bei zeitlichem Risiko ist es, die unsichere Gesamtprojektdauer derart zu planen und zu beeinflussen, dass die Gesamtkosten möglichst minimiert werden. Zu berücksichtigen sind insbesondere Beschleunigungskosten und im Fall einer Überschreitung des vereinbarten Projektendtermins anfallende Strafkosten. Dabei können Vorgänge im Rahmen des Discrete Time-Cost Tradeoff-Problems (DTCTOP), welches bereits in der deterministischen Form NP-schwer ist, in bestimmten Ausführungsmodi verkürzt werden. Die Inanspruchnahme eines Modus führt zu einer Beschleunigung eines oder mehrerer Vorgänge und verursacht entsprechend modusabhängige Kosten.

Im Verlauf eines Projektes unter Risiko liegen dem Entscheidungsträger zunehmend präzisere Informationen hinsichtlich der unsicheren Vorgangsdauern vor. Daher wird vorgeschlagen, die Planungen im Rahmen eines dynamischen Ansatzes rollierend zu aktualisieren und entsprechende Maßnahmen zur Projektsteuerung einzuleiten. Für das vorliegende Entscheidungsproblem wird anhand von Simulationsstudien untersucht, wie sich die Risikoeinstellung der Projektleitung auf die optimale Höhe und den Zeitpunkt des steuernden Eingriffs auswirkt.

4.6 Section 6: Marketing and Data Analysis

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 08 (see p. 38 for session)

Baier, Daniel *(Brandenburg University of Technology Cottbus)*
Brusch, Michael *(Brandenburg University of Technology Cottbus)*

Linking Conjoint Analysis and Quality Function Deployment for Optimal Product Design

Quality Function Deployment (QFD) is a popular product planning tool which has been developed by Japanese engineers in the 70s to assure that the voice of the customer is heard all the way throughout the product development process (see, e.g., Akao 1990, Brusch et al. 2001). Recently, the usage of conjoint analysis has been proposed in this context: It can be used for estimating the importance of desired customer attributes (see, e.g., Spataro, De Sanctis, Parravicini 1990, Gustafsson 1996) and "additionally" for relating them to engineering characteristics (see, e.g., Baier 1998, Baier, Sauer, Kant 2000). Using these functional relationships and descriptions of competing products algorithms for optimal product design (see, e.g., Baier, Gaul 1999 for a review) can be applied. The traditional QFD approach as well as the new methodology are discussed. Applications are used to demonstrate and illustrate advantages of the new methodology over the traditional QFD approach.

Akao, Y., QFD: Integrating Customer Requirements into Product Design, Productivity Press, Cambridge, MA, 1990.

Baier, D., Conjointanalytische Lösungsansätze zur Parametrisierung des House of Quality, in: VDI-GSP (Hrsg.), Quality Function Deployment Produkte und Dienstleistungen marktgerecht gestalten, VDI Verlag, Düsseldorf, 1998, 73–88.

Baier, D., Gaul, W., Optimal Product Positioning Based on Paired Comparison Data, Journal of Econometrics (1999), Vol. 89, Nos. 1–2, 365–392.

Baier, D., Sauer, M., Kant, M., Erfassung und Bewertung des Kundennutzens bei Luxusgütern in: VDI-GSP (Hrsg.), Erfolgreiches Entwicklungsmanagement. Brusch, M., Trilk, H., Dinse, C., Treppa, A., Gemeinsam stärker. Integration von Quality Function Deployment und Target Costing, Qualität und Zuverlässigkeit (2001), Heft 10, 1306–1310.

Gustafsson, A., Customer Focused Product Development by Conjoint Analysis and Quality Function Deployment, Department of Quality Technology, Linköping University, Linköping, 1996.

Spataro, B., De Sanctis, T., Parravicini, G., Conjoint Analysis and Quality Function Deployment, in: Symposium on New Ways in Marketing and Marketing Research, EMAC/ESOMAR, Athens, 1990, 257–278.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 08 (see p. 42 for session)

Bomhardt, Christian *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*
Gaul, Wolfgang *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*
Schmidt-Thieme, Lars *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*
Thoma, Patrick *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*

Web Robot Detection

Web usage data analysis has to face the problem that parts of the underlying logfiles are created by robots. While cooperative robots identify themselves and obey to the instructions of server owners not to access parts or all of the pages on the server, malignant robots may camouflage themselves and have to be detected by web robot scanning devices. We describe robot detection methodology and show that highly accurate tools can be applied to decide wether session data was generated by a robot or user.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 08 (see p. 54 for session)

Born, Stefan *(Mathematisches Institut, Universität Gießen)*
Schmidt-Thieme, Lars *(Inst. für Entscheidungstheorie und Unternehmensforschung, Univ. Karlsruhe)*

Optimal Discretization of Quantitative Attributes for Association Rules

Association rules for objects with quantitative attributes require the discretization of these attributes to limit the size of the search space. As each such discretization might collapse attribute levels that need to be distinguished for finding association rules, optimal discretization strategies are of interest. In 1996 Srikant and Agrawal formulated an information loss measure called *measure of partial completeness* and claimed that equidepth partitioning (i.e. discretization based on base intervalls of equal support) minimizes this measure. We prove that in many cases equidepth partitioning is not an optimal solution of the corresponding optimization problem. In simple cases an exact solution can be calculated, but in general optimization techniques have to be applied to find good solutions.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 08 (see p. 42 for session)

Decker, Reinhold *(University of Bielefeld)*

Identifying Patterns in Buying Behavior by Means of Growing Neural Gas Network

The investigation of buying behavior has a long tradition in quantitative marketing research, especially with respect to the analysis of point of sales scanner data. One category of methods which has gained an increasing attention in this context are artificial neural networks. In this presentation an application-oriented modification of the well-known neural gas network approach (Martinetz/Schulten (1994)) is discussed regarding its suitability for identifying cross category dependencies in observed market baskets (Russell/Petersen (2000) and Decker/Monien (2003)). The approach to be introduced is an extension of the so-called "Grow When Required Neural Network" recently published by Marsland et al. (2002) and is flexible concerning both the structure and the size of the resulting network.

The functionality of our approach will be demonstrated on the basis of point of sales scanner data provided by a German retail chain.

Decker, R.; K. Monien (2003): Market basket analysis with neural gas networks and self-organizing maps, to appear in: Journal of Targeting, Measurement and Analysis for Marketing.

Marsland, S.; J. Shapiro; U. Nehmzow (2002): A self-organising network that grows when required, Neural Networks.

Martinetz, T.; K. Schulten (1994): Topology representing networks, Neural Networks.

Russell, G. J.; A. Petersen (2000): Analysis of cross category dependence in market basket analysis, Journal of Retailing.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 08 (see p. 50 for session)

Hilbert, Andreas *(Lehrst. f. Math. Methoden der Wirtschaftswissenschaften, Univ. Augsburg)*

Ein Modell zur Erklärung der Kundenbindung im Automobilsektor

Die zunehmende Globalisierung der Wirtschaft sowie der gestiegene Kosten- und Wettbewerbsdruck haben in den vergangenen Jahren dazu geführt, dass das Thema Kundenbindung immer mehr an Bedeutung gewonnen hat. Dies gilt insbesondere auch für den Automobilsektor. Allerdings besteht immer noch keine abschließende Klarheit darüber, welche Determinanten letztendlich auf Kundenseite für loyales Verhalten und damit für Kundenbindung verantwortlich sind.

Deshalb versucht die vorliegende Arbeit einen theoretischer Erklärungsansatz zu erarbeiten, der dazu geeignet erscheint, sowohl das Phänomen der Markenloyalität als auch das Phänomen der Händlerloyalität (bzw. -bindung) zu erklären. Dazu wird basierend auf den Ergebnissen eines Literaturstudiums sowie einer theoretisch geleiteten, kausalanalytischen Diskussion unter Berücksichtigung verschiedener Einflussfaktoren – wie z.B. der Produkt- und Händlerzufriedenheit, des Images der Marke, des Wunsches nach Markenwechsel, der Attraktivität der Konkurrenzmarken, des Involvements (also Bedeutung des Produktes für den Einzelnen) sowie des Einflusses des sozialen Umfeldes – ein ganzheitliches Modell zur Erklärung der Kundenbindung im Automobilsektor entwickelt.

Im Anschluss daran erfolgt eine Operationalisierung und empirische Überprüfung des Modells anhand einer Untersuchung bei Kunden großer deutscher Automobilunternehmen mittels LISREL sowie weiterer multivariater Verfahren.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 08 (see p. 54 for session)

Michaelis, Lea *(Humboldt-University Berlin)*
Hildebrandt, Lutz *(Humboldt-University Berlin)*

Using Choice Data to Model Preference Changes

Changes in the competitive market structure after the introduction of a new brand or the elimination of an existing brand can be attributed to changes in preferences and perception. Until now not much attention has been given to these effects on the individual brand choice level. Several hypotheses about how the entry of a new brand affects choice can be derived from research on context effects (e.g. Simonson and Tversky 1992). However not much is known about the effects that arise from the disappearance of choice alternatives. The lack of a suited methodology and the shortcomings of traditional choice models may be the reason why to date the effects of a brand entry or exit have not been examined sufficiently with real world choice data. Static approaches to evaluate competitive relations among brands are given by the well known market structure analysis (Shocker et al. 1990) but there is a lack of more dynamic approaches which analyse individual choice data. In our paper an extension of a recent approach to market structure analysis (Chintagunta 1994) is applied to measure structural changes in markets with scanner panel data. In this framework alternative hypotheses on changes in preference structure, segment structure and product positions can statistically be tested by means of model restrictions. Three aspects are central to this approach: to model market structure on individual level scanner panel data taking into account heterogeneity, to extract a product-market map which represents both the competitive relations and the preference structure, and to quantify competitive effects

through a detailed analysis of the dynamics in perception and preference structure. The goal of the current study is to check the performance of this new approach. We conduct a comprehensive simulation study to examine the ability to recover several preference and choice effects in different scenarios.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 08 (see p. 50 for session)

Missler-Behr, Magdalena *(Wirtschaftswissenschaftliches Zentrum, Universität Basel)*
Stöckler, Daniela *(Universität Augsburg)*
Wachter, Nadine *(Wirtschaftswissenschaftliches Zentrum, Universität Basel)*

Kundensegmentierung auf Basis der logistischen Regression

Im Customer Relationship Management (CRM) gibt es inzwischen viele Ansätze zur Kundenbewertung, empirische Beispiele lassen sich bis jetzt nur wenige in der Literatur finden. Es wird ein eigenes Modell zur Ermittlung eines Kundenpotenzialportfolios vorgestellt, das Aspekte der Portfolioanalyse, der Deckungsbeitragsrechnung und von Scoring-Modellen integriert. Die Variablen zur Erklärung des Kundenpotenzials werden mit Hilfe der logistischen Regression ermittelt, deren Ergebnisse auch zur Bestimmung eines Kundeswertes genutzt werden. Dabei wird zwischen zwei Kundengruppen unterschieden: Neukunden und Bestandskunden. Aufgrund des Kundenpotenzialportfolios können gezielt Marketingstrategien für die verschiedenen Kundensegmente abgeleitet werden. Die Ergebnisse basieren auf einem Datensatz mit etwa 50.000 Einträgen eines deutschen Fachverlags.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 08 (see p. 46 for session)

Poukliakova, Lana *(University of Alberta)*

Modeling Brand Loyalty

We provide a direct insight in the issues underlying consumers brand loyalty by applying economic theory of human capital and relevant behavioral theories. We empirically show that by combining research findings into one testable model, we can better understand the phenomenon of consumers loyalty to a brand as well as to gain an insight into how this loyalty can be broken. We find that results of our study based on the intercept survey of consumers product evaluation, need for uniqueness and need for cognition, are generally supportive of our main hypotheses. Finally we propose explanation of the effects found in the study and show their managerial application.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 08 (see p. 54 for session)

Schlecht, Volker *(Inst. f. Entscheidungstheorie und Unternehmensforschung, Univ. Karlsruhe)*

A New Algorithm for Fuzzy Two-Mode Clustering

Two-mode cluster analysis is a useful technique which has been applied to many fields, e.g. marketing. By connecting first and second mode clusters to each other, we get a description of the resulting classification of the first mode elements just by looking at the corresponding second mode elements and vice versa. In two-mode cluster analysis non-overlapping and overlapping versions are available, which can be used as fuzzy versions. The aim of this talk is to compare the performance of a new algorithm for fuzzy two-mode-clustering to those of known two-mode cluster analysis approaches.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 08 (see p. 42 for session)

Schmidt-Mänz, Nadine S. *(Inst. f. Entscheidungsth. u. Unternehmensforsch., Univ. Karlsruhe)*
Gaul, Wolfgang *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*

Measurement of Online Visibility

To attract web visitors via the internet it is fundamental for all kinds of online activities to be "visible" in the net. Visibility Measurement is important for websites: It helps to define benchmarks with respect to competition and allows to calculate visibility indices as predictors for traffic.

This paper discusses a new approach to measure online visibility (OV) and compares it with one from Drèze/Zufryden. We describe physical and psychological drivers of OV and suggest a measurement of OV that works automatically as a robot in the internet. Managerial implications to make websites "smelly" or "visible" are also discussed.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 08 (see p. 46 for session)

Scholz, Sören W. *(Lehrstuhl für Betriebswirtschaftslehre und Marketing, Universität Bielefeld)*

Konzeption eines intelligenten Systems zur Überwachung unternehmensrelevanter Marktentwicklungen

Das frühzeitige Entdecken relevanter Veränderungen in der Unternehmensumwelt stellt einen wichtigen Aspekt der strategischen Planung und damit eine wichtige Determinante des zukünftigen Unternehmenserfolges dar. Das World Wide Web liefert einen kostengünstigen Zugang zu vielen Informationen, die als so genannte ,,schwache Signale" Rückschlüsse auf zukünftige, strategisch relevante Entwicklungen der Unternehmensumwelt zulassen (Ansoff (1979)). Allerdings verhindert die fehlende Struktur sowie die immer größer werdende Anzahl an verfügbaren Quellen und Dokumenten eine umfassende Überwachung der im Internet verfügbaren Informationen.

Ziel dieses Beitrags ist die Konzeption eines intelligenten Systems, das im Internet strategierelevante Informationen für den betrieblichen Entscheidungsträger sucht, selektiert, aufbereitet und bereitstellt. Die Umsetzung des Konzeptes erfolgt mittels der Information Foraging Theory als einem modernen Ansatz zur Modellierung von menschlichem Informationssuch- und -auswahlverhalten (Pirolli/Card (1999)). Die aus der Kognitionspsychologie stammende Methodik ermöglicht neben der Betrachtung der Informationsqualität und -relevanz einzelner Dokumente auch die Bewertung der generellen Verfügbarkeit von geeigneten Dokumenten in der Informationsumgebung.

Die entwickelte Vorgehensweise wird anhand einer experimentellen Studie vorgestellt.

Ansoff, I. H. (1979): Strategic Management, Macmillan, London.

Pirolli, P.; S. Card (1999): Information Foraging, Psychological Review, Vol. 106, No. 4, 643 - 675.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 08 (see p. 50 for session)

Staack, Yvonne *(McKinsey & Co. Hamburg)*

Determinants and Behavioral Consequences of Customer Loyalty and Dependence in Online Brokerage: Results from a Causal Analysis

Since the worldwide boom of the internet in the 1990-ies, numerous online businesses have been established. Online brokerage emerged as a means for private investors to trade stocks, bonds, and other securities in almost real-time and at a fraction of the cost for traditional (offline) trading. Starting their e-business, these online brokers naturally focussed on generating enough traffic to acquire as many customers as possible. However, in the online world, the competition is only a mouse-click away and "natural" exit barriers like locational constraints seem to fade. Thus, in order to survive in the long-run, e-service providers must convert their first-time users into regular customers to regain their acquisition costs (which are usually not recovered by one single transaction) and turn these relationships into profitable ones. But what determines a customer to be loyal to and/or dependent on his current online broker? And, if a customer can be successfully retained, what effect will that have on the company's profits?

Based on sound theoretical research a generic model for the development, the dimensions, and the behavioral consequences of customer retention is proposed. Based on a survey of more than 4.500 online brokerage users of a well-known German financial institution, this customer loyalty/dependence-model is tested empirically using the method of causal analysis (AMOS). A discussion of the practical implications of the results for the online broker concludes the presentation.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 08 (see p. 38 for session)

Stauß, Bernd *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*
Gaul, Wolfgang *(Inst. f. Entscheidungstheorie u. Unternehmensforschung, Univ. Karlsruhe)*

Product Bundling as a Marketing Application

Product bundling describes an interdisciplinary problem of great importance. It can be used to tailor offers to the demand of consumer segments (marketing), it helps to tackle variety reduction management issues (production), it is based on consumer preferences (data analysis), and it needs combinatorial optimization for solution (operations research).

In this paper a new profit-maximizing mixed integer product bundling approach is presented that works well for modest problem instances. Additionally a heuristic is derived that copes with the situation in a Greedy-like manner for larger problem instances by providing a sequence of monotone increasing lower bounds for the objective function of our product bundling methodology.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 08 (see p. 38 for session)

Thoma, Patrick *(Universität Karlsruhe)*
Gaul, Wolfgang *(Universität Karlsruhe)*
Bergh, Sven van den *(Mentasys GmbH, Karlsruhe)*

Using Multidimensional Scaling in Recommender Systems

"Recommender Systems" is the label for a methodology to guide online users through complex websites, hugh online-stores or any other kind of information that can not be overviewed or searched through completely. These systems use, among others, historical data about user preferences to recommend items the user might be interested in. After presenting a framework that can be used to classify different recommender systems, we give a short overview about some of the most popular recommender systems and explain briefly methods used to create recommendations. From an empirical point of view, we analyzed data gathered from a large German retail online store that uses a rule-based recommender system for a special product class. The customer receives a sorted list of items that "best" match her/his search queries. We conducted a multidimensional scaling (MDS) to visualize the different search queries together with the recommendable items of the product domain. Combining both allowed us to compare the recommendations of the status-quo-system with the most appropriate products that would have been recommended within the MDS approach according to their similarities to the search queries. The results gave as important hints on how to further improve the generation of recommendations.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 08 (see p. 46 for session)

Wagner, Udo *(Universität Wien)*
Reisinger, Heribert *(Universität Wien)*
Schuster, Matthias *(Universität Wien)*

Ein einfaches Modell zur Bestimmung des Markenwechselverhaltens auf Konsumgütermärkten

Die Modellbildung im Marketing erfolgt häufig als Kompromiss zwischen den beiden Extrempositionen einer möglichst vollständigen Berücksichtigung der wichtigsten Umfelddeterminanten auf das interessierende Phänomen und einer leichten Verwendbarkeit in der Managementpraxis. Für das Problem der Schätzung von Markentreue bzw. Markenwechselintensitäten auf Konsumgütermärkten haben wir uns in früheren Arbeiten vornehmlich der ersten Sichtweise zugewandt und einschlägige Lösungsvorschläge entwickelt, die auf einer umfangreichen Datenbasis und komplexen Schätzverfahren aufbauen. Dieser Beitrag fokusiert in die andere Richtung und versucht auszuloten, wie weit die propagierten Ansätze vereinfacht werden können, ohne all zu viel von ihrer Leistungsfähigkeit einzubüsen. Konkret gelingt es uns, die Komplexität so weit zu reduzieren, dass das nunmehr zur Diskussion gestellte Modell mit einfachen Hilfsmitteln (bspw. Spreadsheet-Software) kalibriert werden kann und mit einer bescheidenen Datenbasis das Auslangen findet. Wir belegen die Leistungsfähigkeit des Ansatzes sowohl an Hand von empirischen Daten als auch mit Hilfe von Simulationsstudien.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 08 (see p. 50 for session)

Weber, Klaus *(Lufthansa Systems Berlin)*
Gröwe-Kuska, Nicole *(Humboldt-Universität zu Berlin)*
Cromme, Ludwig *(Brandenburgische Technische Universität Cottbus)*

Marketing Decision Support by Means of Stochastic Programming in a Fuzzy Environment

Based on a software tool for support of the acquisition process in marketing, we present two models and related stochastic programs. Since some of the quantities involved are subject to human assessment, the models are set in a fuzzy environment. Our central model, the basic acquisition plan, BAP, is a directed graph where nodes correspond to marketing actions and edges to customer reactions, respectively. First, we consider the problem to maximize customer throughput subject to fuzzy capacity restrictions of marketing actions. The related stochastic integer program is transformed into a stochastic transport problem with complicating constraints and finally solved by augmented Lagrangian method. The second model is rooted in the Bellman/Zadeh dynamic fuzzy optimization approach. Owing to the limited capability to consider customer distinctions in BAP, we extend BAP to dynamic acquisition plans, DAP. They model the acquisition process as multistage stochastic fuzzy decision process with implicit termination time in a state space which is based upon customer segments. We show how the optimal policy can be calculated iteratively using a fixed point theorem and which t-norms are applicable. Both models, BAP and DAP, are illustrated by case studies. The models are particularly suitable for applications where much customer data is processed and stored, e.g. in e-commerce, customer loyalty programs, reservation systems, etc.

4.7 Section 7: Energy, Environment and Health

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 57 for session)

Fichtner, Wolf *(Universität Karlsruhe)*
Rentz, Otto *(Universität Karlsruhe)*

Entwicklung und Anwendung einer mehrstufigen Methodik zur Analyse betriebsübergreifender Energieversorgungskonzepte

Im Rahmen des Vortrags wird eine Methodik zur Analyse von betriebsübergreifenden Energieversorgungskonzepten und deren Anwendung präsentiert. Der Lösungsansatz besteht aus einer mehrstufigen Methode, die sich aus einer technischen Analyse, einer techno-ökonomische Optimierung und einer Aufteilung der Kosteneinsparung auf die Kooperationspartner zusammensetzt. Die technische Analyse unter Einsatz des Flow-Sheeting-Simulations-Programms Aspen Plus hat als Ziel die Ausarbeitung von an die spezifischen Gegebenheiten angepassten Anlagenkonfigurationen. Für die sich anschließende techno-ökonomischen Optimierung werden die so ausgelegten und die existierenden Energieumwandlungsanlagen der Unternehmen mit Hilfe von technischen, ökonomischen und umweltrelevanten Parametern nachgebildet. Durch eine mehrperiodige gemischt-ganzzahlige lineare Optimierung erfolgt die Ermittlung ausgabenminimaler Energieversorgungsstrategien. Der dritte methodische Schritt widmet sich dem Problem, wie die Kosten und Gewinne der Kooperation auf die beteiligten Unternehmen aufzuteilen sind. Dazu werden verschiedene betriebswirtschaftliche und spieltheoretische Methoden auf ihre Anwendbarkeit untersucht.

Im Rahmen einer exemplarischen Anwendung dieser Methodik auf die TechnologieRegion Karlsruhe werden verschiedene kooperative Energieversorgungsoptionen einzelbetrieblichen Strategien gegenübergestellt. Die gemeinsame Energieversorgung mehrerer Unternehmen durch eine zentrale Gas- und Dampfturbinenanlage (GuD-Anlage) erweist sich dabei in ökonomischer und ökologischer Hinsicht als vorteilhaft gegenüber der Fortführung von einzelbetrieblichen Strategien. Durch die effiziente Energieumwandlung der GuD-Anlage ergibt sich eine jährliche Kosteneinsparung von bis zu 38 Mio. und eine Reduktion der CO2-Emissionen um ca. 31 % gegenüber der unterstellten Referenzentwicklung. Eine stabile Lösung der Gewinnaufteilungsproblematik lässt sich durch Berechnung des Shapley-Wertes bestimmen.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 50 for session)

Fleßa, Steffen *(Department of Public Health, University of Heidelberg)*

Many Worlds of Health: A System Dynamics Model of the Epidemiological Transition

The share of infectious and chronic diseases in the total burden of disease changes with the phase of the demographic transition. Health care resource allocation decisions have to quantify these shares. Therefore, a system dynamics model is presented that allows to analyse the influence of different pattern of fertility transition, technical progress and hygiene. The impact on resource allocation in African developing countries is discussed.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 57 for session)

Fröhling, Magnus *(Institute for Industrial Production, University of Karlsruhe)*
Schultmann, Frank *(Institute for Industrial Production, University of Karlsruhe)*
Nebel, Falk *(Institute for Industrial Production, University of Karlsruhe)*
Rentz, Otto *(Institute for Industrial Production, University of Karlsruhe)*

Mass- and Energy-Flow Orientated Master Production Scheduling

In this paper an approach for master production scheduling is presented that combines process simulation with a linear mass- and energy-flow orientated master production scheduling model. First results of a practical application to a waste utilisation process are shown providing decision support in short-term production planning for a real world case from the metal industry. The considered production process consists mainly of a sinter strand and a blast furnace adapted to produce foundry pig iron and a highly concentrated zinc sludge while utilising wastes from the metal industry.

The sinter strand and the blast furnace are modelled with a flow sheeting system, using inter alia so called Continuous Stirred Tank Reactors (CST-Reactors) as a unit-operation model capable of considering dynamic system changes. This ensures that the obtained input-output relations consider technical particularities of the underlying metallurgical processes. The input-output factors obtained by process simulation are used as parameters for a linear master production scheduling (MPS) model that is implemented in a commercial solver.

The objective function of the MPS model maximises the contribution margin. Revenues by the sale of products (different types of foundry pig iron and a zinc concentrate) and treatment charges for raw materials resulting from the utilisation of metal containing wastes are considered as well as costs for the disposal of by-products and costs for raw materials and energy needed to carry out the production processes. Process-specific constraints as the relationships between the utilisation of the wastes on the one hand and the effects on product quality and the consumption of raw materials and energy on the other hand are considered. To ensure that the imprecision evoked by the approximation

of the non-linear production processes with the linear model is within determined bounds the results are again coupled with the flow sheeting system.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 54 for session)

Geldermann, Jutta *(Deutsch-Französisches Institut für Umweltforschung, Universität Karlsruhe)*
Avci, Nurten *(Deutsch-Französisches Institut für Umweltforschung, Universität Karlsruhe)*
Rentz, Otto *(Deutsch-Französisches Institut für Umweltforschung, Universität Karlsruhe)*

Produktprogrammplanung in Unternehmen der Lackproduktion unter besonderer Berücksichtigung der Auswirkungen neuer umweltgesetzlicher Regelungen

Neue umweltgesetzliche Regelungen zur Reduktion der Emissionen flüchtiger organischer Verbindungen haben einen wesentlichen Einfluss auf die Produktprogramme von Lackproduzenten. Insbesondere aufgrund der vom Gesetzgeber den Lackanwendern gegenüber zugestandenen Flexibilität und der vielfältigen Produkt- und Techniksubstitutionen in der Lackierung bedarf es einer neuen strategisch-taktischen Produktprogrammplanung der Lackproduzenten. Dabei lässt sich die Unsicherheit hinsichtlich der Durchsetzbarkeit neuer Produkte auf dem Lackmarkt reduzieren, wenn ihre Akzeptanz bei den Lackanwendern erfasst sowie die auf Anwenderseite entstehenden Einführungskosten frühzeitig abgeschätzt werden können. Überdies ist die Abschätzung der Entwicklungen auf dem Endkundenmarkt (z. B. Nachfrage nach Autoreparaturlackierung), der die Nachfrage nach Lackprodukten indirekt beeinflusst, von Bedeutung.

In diesem Beitrag wird die Eignung des Stoffstrommanagements für die strategisch-taktische Produktprogrammplanung der Lackproduzenten untersucht. Am Beispiel der Region Baden-Württemberg wird die Entwicklung und Anwendung des Stoffffluss- und Optimiermodells ARGUS-Lack vorgestellt. Durch die Kombination des Stoffstrommanagements mit einem linearen Optimiermodell wird eine systematische Informationsbeschaffung sowie eine Analyse der Auswirkungen neuer umweltgesetzlicher Regelungen auf den Lackanwendermarkt möglich.

Hiermit steht den Lackproduzenten ein Instrument zur Analyse des Leistungsaustausches mit ihren zahlreichen Kunden (meist Kleinstunternehmen) zur Verfügung, das trotz einer sehr heterogenen Marktstruktur eine transparente Darstellung der techno-ökonomischen und ökologischen Entwicklungen gewährleistet und dadurch die Ableitung von planungsrelevanten Informationen für die Produktprogrammplanung ermöglicht.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 50 for session)

Günther, Hans-Otto *(Technische Universität Berlin)*
Grunow, Martin *(Technische Universität Berlin)*
Yang, Gang *(Technische Universität Berlin)*

Einsatzplanung für medizinisches Personal in klinischen Studien

Klinische Studien zur Entwicklung neuer Wirkstoffe in der pharmazeutischen Industrie folgen einem genau festgelegten Ablauf mit verschiedenen Aktivitäten, die hinsichtlich ihres Inhalts, der Dauer, des zeitlichen Abstands zum Beginn der Studie und des Typs des benötigten medizinischen Personals definiert sind. In unserem Vortrag analysieren wir die Einsatzplanung für das benötigte medizinische Personal, wobei davon ausgegangen wird, dass innerhalb eines kurzfristigen Planungshorizontes (i.d.R. ein einzelner Tag) mehrere Studien gleichzeitig auszuführen sind. An Stelle eines komplexen monolithischen Modells wird ein hierarchischer aufgebauter Lösungsansatz vorgeschlagen. In der ersten Stufe werden die Beginnzeiten der einzelnen Studien mit Hilfe eines kompakten gemischt-ganzzahligen, linearen Optimierungsmodells sowie die Zuteilung von Kapazitäten des vorhandenen medizinischen Personals bestimmt. Wesentliche Nebenbedingungen bestehen in der Einhaltung von Kapazitätsschranken für die einzelnen Personalgruppen. Die Zielsetzung besteht darin, die Kosten für Zusatzpersonal zu minimieren. Die Zuteilung von Einzelpersonen der verschiedenen Personalgruppen zu den individuellen Aktivitäten der verschiedenen Studien erfolgt dann in der zweiten Stufe des Lösungsansatzes mit Hilfe eines binären Optimierungsmodells.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 46 for session)

Küfer, Karl-Heinz *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Monz, Michael *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Scherrer, Alexander *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Bortfeld, Thomas R. *(Massachusetts Gneral Hospital, Boston)*
Thieke, Christian *(German Cancer Research Center, Heidelberg)*

A Multiple-Objective Optimizer for Clinical Radiation Therapy Planning

Clinical radiation therapy is a tight rope walk between underdosing cancer tissue and overdosing critical structures. Ideal planning goals are given in terms of lower bounds for the curative dose in the target volume and tolerance doses for critical structures nearby. Typically, these ideal objectives are conflicting and there is a natural need to compromise

between them. Therefore, it is natural to model optimisation of radiotherapy planning as a multi-criteria optimisation problem. The problem is to find good physical parameters - an optimal irradiation geometry and intensity maps - that guarantee pareto optimal approximations of these ideal goals. Mathematically, this inverse problem can be formulated as a large scale convex multi-criteria program. In order to compute an approximation of a clinically relevant subset of the pareto solutions in reasonable computation time there is need for the definition of an appropriate numerical environment that allows numerous inverse calculation in short time.

The talk will

- show how to define relevant subsets of pareto solution using extreme compromises
- provide a numerical platform using clustering and cutting plane schemes
- demonstrate software with proper clinical examples.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 46 for session)

Monz, Michael *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Küfer, Karl-Heinz *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Trinkaus, Hans L. *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Bortfeld, Thomas R. *(Massachusetts General Hospital and Harvard Medical School, Boston)*
Thieke, Christian *(Deutsches Krebsforschungszentrum, Heidelberg)*

Modelling Clinical Decision Processes for Radiotherapy Planning

Multi-criteria optimisation of radiotherapy planning provides a large data base of several thousand complete radiation therapy plans. It is a challenging task for a decision maker to extract the plans that fit best to the specific requirements of the clinical case. Clearly, there is a strong need for electronic support of this decision process, as a doctor cannot scan or even compare such a vast amount of data. To facilitate comparison and navigation between different plans the data of each treatment plan is organised in a hierarchical structure. Finest information is given by a discretised 3D-dose distribution, intermediate information is given by dose-volume histograms that associate dose levels to volume parts. The coarsest information is provided by so-called EUDs that give average doses for all entities of interest. The information on all three levels is ordered by different order relations. These partial orderings together with appropriate visualisations in a graphical user interface can be used for the design of a decision platform that facilitates the selection of interesting plans by subsequent focusing or defocusing operations that include or exclude parts of the database in a clever way. To quickly direct the focus to the interesting part of the database, wishes can be formulated that are best possible realised using an online-optimisation algorithm.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 46 for session)

Nickel, Stefan *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Eley, Michael *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Kallrath, Julia *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Tenfelde-Podehl, Dagmar *(Technische Universität Graz)*

Planning Patient Transports in Hospitals - Insights and a Project Report

Analyzing logistic processes in hospitals is a quite complex and involved task. On one hand very different kinds of transports have to be managed (meals, patients, blood conserves, drugs, garbage, etc.). On the other hand there is a high uncertainty in the data available. One reason is the intrinsic occurrence of emergency tasks. Another reason is the still underdeveloped availability of well maintained and accurate data.

In this talk we will present a system to plan the transport of patients in hospitals. These can be in-house transports or transports on a hospital campus. We have chosen this specific problem to start with, since the transport of patients is central for many other logistics activities in the hospital. Moreover, in the view of patients, surveys show a very high importance of this topic. In most hospitals the coordination of patient transports is already organized via a central dispatcher. But he is in many cases only equipped with a telephone. We develop the system OptiTrans to support this central dispatcher in order to handle the routine tasks automatically and leave the dispatcher more time for taking care of the emergency tasks. The optimization kernel consists of variants of online vehicle routing problems to deal with the uncertainty and allow an easy replanning. To be able to get and keep the necessary data consistent a tight integration into hospital information systems is provided.

To get an impression of the larger picture we will also report from two ongoing hospital projects with the Klinikum des Saarlandes in Homburg and the Universitätsklinik Mainz. The projects consist of the following seven steps which will be discussed in more detail in the talk: 1. Data analysis/data-mining 2. Development of a simulation model 3. Scenario analysis 4. Optimization of the hospitals structure 5. Process optimization 6. Validation of the optimization results 7. Support during the implementation phase of the software.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 54 for session)

Pickl, Stefan *(Department of Mathematics ZAIK Cologne)*
Betzenbichler, Werner *(TÜV Süddeutschland - Carbon Management Service)*
Grimm, Bernhard *(TÜV Süddeutschland - Carbon Management Service)*
Reed, Alan *(University of Albuquerque - AnnexI Corporation)*

Management and Optimization of Environmental Data within Emission Trading Markets - VEREGISTER and TEMPI

The international effort to reduce atmospheric effects of greenhouse gas (GHG) emissions presents complex problems of information generation and management. Information in all forms - data, calculations, quantities, dates, reports - must all be created, recorded, compiled, maintained, exchanged, analysed and optimized. This is especially important for the initiation of an emission trading market because the market will demand certified units, as close to stock share certificates as possible.

Although the international business world has not agreed on the financial standards and data format for emissions trading, contracts for emission units are already being traded. Regional pilot projects have been operating for several years. The UK and Danish markets, and the Chicago Climate Exchange are in the throes of full implementation. The United Nations Conference on Trade and Development (UNCTAD) initiated prototype software for maintaining registries (updated through trading), inventories, reporting data and forecasting.

This is currently being tested and refined by AnnexI Corporation. The authors present VEREGISTER and the optimization software TEMPI.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: AW 1017 (see p. 54 for session)

Queiruga, Dolores *(Inst. f. Wirtschaftwissenschaften, Abt. f. Produktionswirtschaft, TU Braunschweig)*
Walther, Grit *(Inst. f. Wirtschaftwissenschaften, Abt. f. Produktionswirtschaft, TU Braunschweig)*
Spengler, Thomas Stefan *(Inst. f. Wirtschaftwissenschaften, Abt. f. Produktionswirtschaft, TU Braunschweig)*

Standortplanung für Elektronikschrott-Recyclingunternehmen in Spanien

Nach dem Inkrafttreten der Richtlinie des Europäischen Parlamentes und des Rates über Elektro- und Elektronikaltgeräte (WEEE) muss zukünftig eine ordnungsgemäße Erfassung und Behandlung dieser Geräte am Ende ihrer Lebensdauer gewährleistet werden. Hierfür ist zum einen die getrennte Sammlung der Altgeräte nach vorgegebenen Gerätekategorien erforderlich, zum anderen der Transport zu speziellen Zerlege- und Recyclingunternehmen sowie die Behandlung der Geräte unter Einhaltung bestimmter Anforderungen.

Im vorliegenden Beitrag wird die Umsetzung dieser Richtlinie speziell für Spanien betrachtet, wo derzeit noch sehr wenige Zerlege- und Recyclingunternehmen für Elektronikschrott existieren. Aus diesem Grund sind neben entsprechenden Rücknahme- und Logistiksystemen auch neue Recyclingunternehmen für Altprodukte zu errichten. Unter Berücksichtigung spanischer Besonderheiten, wie beispielsweise der geringen Einwohnerdichte, der großen Transportentfernungen und unter Zugrundelegung bereits bestehender Sammelstellen, potenzieller Altgeräteanfallmengen sowie aktueller Kostendaten wird im vorliegenden Beitrag ein Standortplanungsmodell für Zerlege- und Recyclingunternehmen entwickelt. Verschiedene Szenarien werden mit Hilfe eines gemischt-ganzzahligen Optimierungsmodells (MILP) zur diskreten Standortwahl untersucht. Aus einer Vorauswahl potentieller Standorte erfolgt die Ermittlung der optimalen Standorte. Dabei finden die für die Erweiterung bzw. Veränderung bestehender Strukturen erforderlichen Investitionen und Fixkosten unter Beachtung der notwendigen Kapazitäten und des innerbetrieblichen Layouts ebenso Beachtung wie die variablen Kosten- und Erlösarten der Demontage- und Transportaktivitäten.

Das Modell erlaubt die Ableitung von Handlungsempfehlungen für die Entwicklung eines Rückführ- und Behandlungssystems von Elektronikaltprodukten in Spanien.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1017 (see p. 50 for session)

Zimmermann, Hans-Jürgen *(INFORM, Aachen)*

Optimierung oder globale Effizienzbestimmung in Krankenhäusern?

Anwendungen von OR im Gesundheitswesen sind genau so wenig neu, wie die danach genannte Arbeitsgruppe der GOR. Sie scheinen sich jedoch in der jüngsten Zeit zu verstärken. Indiz dafür sind z.B. die zwei diesem Gebiet gewidmeten Sonderhefte des OR-S und EJOR. Neu – jedenfalls in Deutschland – ist jedoch die stärkere Fokussierung auf Krankenhäuser.

Recht unterschiedlich sind die betrachteten Probleme (von der Layout-Planung zur Radiologie), die vorgeschlagenen Modelle und Lösungsmethoden (von der Simulation über kombinatorische Verfahren bis hin zu DEA und Heuristiken) sowie der jeweils betrachtete zeitliche Rahmen (kurz-, mittel- oder langfristig).

Traditioneller Weise strebt OR nicht nur gute oder optimale Lösungen an, sondern versucht auch, die Lösungswege zu optimieren. Deshalb wäre eine sinnvolle Zuordnung von Lösungsansätzen zu Problemarten auch in dem neuen Anwendungsgebiet des Krankenhauswesens wünschenswert. Im Rahmen dieses Beitrages ist sicher eine vollständige diesbezügliche Taxonomie nicht möglich. Exemplarisch soll diese jedoch an zwei relevanten und auf das Krankenhauswesen bereits angewandten Ansätzen versucht werden und zwar and der MCDM (Multi Criteria Decision Making) (Vektormaximierung) und der DEA (Data Envelopment Analysis). Diese Ansätze sind zwar sehr verschieden im Charakter. Sie haben jedoch einen inneren Zusammenhang und ergänzen sich in mehreren Hinsichten.

4.8 Section 8: Finance, Banking and Insurances

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 10 (see p. 42 for session)

Branger, Nicole *(Goethe University Frankfurt)*
Mahayni, Antje *(University of Bonn)*

Tractable Hedging – An Implementation of Robust Hedging Strategies

This paper provides a theoretical and numerical analysis of robust and tractable hedging strategies in a stochastic volatility model. A hedging strategy is called robust if it is a superhedging strategy in a corresponding uncertain volatility model where volatility is always within some interval. Avellaneda, Levy and Parás (1995) show that the minimal initial capital needed can be calculated as the solution to a Black-Scholes Barenblatt equation.

While the cheapest robust hedge for a convex or concave payoff is a Gaussian strategy, this does not hold for any other payoff. We decompose each payoff into a portfolio of long and short positions in convex claims and set up a robust hedge by hedging each component payoff separately. The resulting hedging strategy is the sum of Gaussian strategies, which we call a tractable strategy. We show that the cheapest tractable robust hedge can be represented by one long and one short position in convex claims. Surprisingly, for the optimal choice of these two claims it may hold that the portfolio out of these claims truly dominates the payoff to be hedged. For a bullish vertical spread, e.g., it may indeed be cheaper to find a tractable hedge for a dominating portfolio than for the claim itself.

We illustrate our results in a numerical example and analyze the performance of different hedging strategies in a stochastic volatility model with unbounded volatility. We compare the initial capital of the cheapest tractable robust hedge to the initial capital of the cheapest robust hedge determined by Avellaneda et al. The additional capital needed implies a greater robustness of the strategy, i.e. on average, the losses decrease. We analyze the cost processes and identify the paths for which the strategies lose money and the paths for which there is additional robustness. These paths can be described by a critical volatility. We also analyze the shortfall probabilities of different hedging strategies.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 10 (see p. 38 for session)

Breitner, Michael H. *(Institut für Wirtschaftsinformatik, Universität Hannover)*
Kubertin, Oliver *(Institut für Mathematik, Technische Universität Clausthal)*

WARRANT-PRO-2: A GUI-Software for Easy Evaluation, Design and Visualization of European Double-Barrier Options

In 2001 the first version WARRANT-PRO-2 (0.1) has been presented, see M. H. Breitner and T. Burmester, Optimization of European Double-Barrier Options via Optimal Control of the Black-Scholes-Equation, in Chamoni, P., et al. (Eds.), OR Proceedings 2001, pp. 167 – 174, Springer, Berlin, 2002. WARRANT-PRO-2 optimizes cash settlements for European double-barrier options and warrants. From the viewpoint of (financial) mathematics, boundary conditions of the partial differential Black-Scholes equation are parameterized. The Black-Scholes equation is solved with numerical Crank-Nicholson schemes and the parameters are optimized by nonlinear programming, i. e. an advanced SQP-method.

In the upgraded version WARRANT-PRO-2 (0.2) an option's deviation from a predefinable Delta (performance index) is minimized. The global error order of the Crank-Nicholson scheme is now quadratic in time (option's time to maturity) and space (market price of the option's underlying). The gradient of the performance index is computed highly accurate with automatic differentiation. Now a Matlab-GUI (graphical user interface) allows easy evaluation, design and visualization of options and warrants. WARRANT-PRO-2 (0.2) and its GUI run "stand alone" on LINUX PCs and Laptops. Optimized options can combine the advantages of futures and options. Delta can be made almost constant for long periods and for a wide range of underlying market prices. Thus, no Delta-hedge adaptation is required. Moreover, tedious margining is not necessary. Optimized European double-barrier options are very interesting derivatives for both buyer and issuer and can revolutionize modern financial markets.

After an introduction into the mathematical background, a software demonstration is the second part of the presentation. Different examples show the performance and flexibility of WARRANT-PRO-2 (0.2). Screenshots, examples and details can be found on the IWI-WWW-page `www.iwi.uni-hannover.de`.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 10 (see p. 42 for session)

Doege, Jörg *(Institut für Operations Research, ETH Zürich)*
Schiltknecht, Philippe *(Institut für Operations Research, ETH Zürich)*

Using Financial Engineering for the Valuation of Operational Flexibility

Knowing the value of operational flexibility is becoming more and more important for companies that are operating in competitive and deregulated markets. It is essential as companies with this knowledge have an advantage in dispatching their production while maximizing the value of their assets based on a given level of risk. Furthermore they can only be successful players if they know what flexibility is worth in order to act and react in the market by e.g. engineering new products. Thus, companies have to know how to use the flexibility as an instrument.

Our approach to this problem will combine methodologies from the modern risk management with the economic value of potential flexibilities. Hence, we will derive and explain the value of operational flexibility in the context of the intimate relationship between coherent risk measures (due to Artzner, Delbaen et al) and convex optimization. This discussion of risk measurement will encompass portfolio optimization using the conditional Value-at-Risk (CVaR).

In the second part we will show how industries can use this generalized approach as an instrument of controlling and dispatching for their production in order to increase their market force. We will present a recent application in the energy sector, where such a risk management technique is used to derive an optimal dispatch policy for hydro storage plants in the framework of real option theory. Another example that will be provided is from the chemical industry where those techniques are applied in order to use the underlying scheduling flexibility.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 10 (see p. 51 for session)

Dorfleitner, Gregor *(Universität Augsburg)*

How Short-Termed is the Trading Behavior in German Futures Markets?

The paper empirically investigates smoothing-out ratios and average holding periods of different Eurex futures such as the Euro-Bund, the DAX, the DJ Euro STOXX 50 future and others from 1999 to 2002. A methodology that only needs daily volume and open interest data is presented (including an innovative open interest correction algorithm). The resulting average holding period covers all positions held in the futures contract under consideration. It can be shown that average holding periods decrease over time in most of the examined futures. Other interesting results are the June contract phenomenon in the DAX future and a 09/11 effect in several Eurex futures.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 10 (see p. 51 for session)

Fink, Claudia *(Universität Graz)*

Modellanalytische Preis-Gleichgewichtsbeziehungen auf Kassa- und Terminmärkten

Mit der Information Preis werden in aller Regel subjektive Vorstellungen verknüpft: Preise/ Zinsen können als hoch oder niedrig erachtet werden und scheinen sich tatsächlich auf subjektive Einschätzungen der Marktteilnehmer zu beziehen. Im Rahmen dieses Beitrages soll der Frage nachgegangen werden, ob ein Preissystem unabhängig von den Risiko-Nutzen-Einstellungen bzw. den Präferenzen der Marktteilnehmer gefunden werden kann: Ein solches Preissystem müsste ein Gleichgewicht implizieren und demzufolge Arbitrage ausschließen und von allen Marktteilnehmern als fair und gerecht empfunden werden. Das Preissystem ist dann unabhängig von den Einschätzungen der Wahrscheinlichkeiten (believes) und von den Zeit- und/oder Risikopräferenzen (tastes) der Marktteilnehmer. Befindet sich ein Preissystem hingegen im Ungleichgewicht, dann existiert nach Dothan eine Handelsstrategie ,,that gives a trader with zero endowment a nonnegative, nonzero, consumption process“ (Dothan 1990).

Wird in der Literatur von Preissystemen gesprochen, dann stehen derartige Überlegungen im engen Zusammenhang mit dem Begriff der Arbitrage. Im Rahmen dieses Beitrages wird eine der strengsten Definitionen von Arbitrage verwendet, die im wesentlichen auf Harrison/Kreps 1979 zurückgeht. Die Bedingungen für ein für zwei Volkswirtschaften gemeinsames Marktgleichgewicht (bzw. für ein globales viable price system) werden über Pseudodiskontfaktoren bzw. normierte Preise erreicht, während ein gleichgewichtiger Kassa- und Terminwechselkurs über die Märktevergleichsrechnung hergeleitet wird. Gemeinsam daraus ergeben sich dann die Bedingungen für ein Gleichgewicht zwischen Zinsstruktur, Wechselkurs und (Wertpapier-)Preissystem, wodurch eine integrierte Rendite-Risiko-Steuerung möglich wird.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 10 (see p. 51 for session)

Klein, Christian *(Institut für Statistik und Math. Wirtschaftsforschung, Univ. Augsburg)*
Dorfleitner, Gregor *(Institut für Statistik und Math. Wirtschaftsforschung, Univ. Augsburg)*

Der Einfluss von Handelssystemen auf die Volatilität eines Investments

Unter einem "Handelssystem" versteht man in der Praxis allgemein ein System von Regeln und Auswertungsverfahren, welches Kauf- und Verkaufssignale für ein Investitionsobjekt (z.B. ein Zertifikat oder eine Aktie) generiert. Die Anwendung kann computergestützt oder manuell erfolgen. Die Generierung der Signale erfolgt beispielsweise mit Mitteln der fundamentalen oder der technischen Aktienanalyse. Ziel ist es, einerseits durch möglichst billiges Kaufen und möglichst teueres Verkaufen bessere Renditen als bei einer Buy-and-Hold Investition zu erzielen, anderseits werden Handelssystemen ein reduzierender Einfluss auf das Risiko einer Investition nachgesagt.

Durch das systematische Investieren und Deinvestieren in das Investitionsobjekt wird versucht, die Volatilität der Investition gegenüber Buy-and-Hold zu reduzieren. Allerdings hat die dabei verwendete Strategie, welche die durch das Handelssystem generierten Signale in konkrete Transaktionen mit den dazugehörigen Cashflows übersetzt, einen erheblichen Einfluss auf die Periodenrenditen und somit auf die Volatilität. Dabei unterscheiden wir in drei Klassen von Strategien (Reinvesting, Rebalancing und Shortstrategien).

Es kann gezeigt werden, dass die Verwendung von Handelssystemen einen negativen Effekt auf die Volatilität haben können. Dies ist bei allen drei Investitionsstrategien der Fall. Die Frage, ob eine prinzipielle Reduzierung des Risikos durch Handelssysteme möglich ist, muss somit verneint werden.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 10 (see p. 46 for session)

Kleine, Andreas *(University of Hohenheim)*

Conditional Value-at-Risk bei diskreten Zufallsvariablen

Für das Risikomanagement hat der Value at Risk (VaR) in der Vergangenheit speziell im Finanzsektor eine große Bedeutung erlangt. Der VaR repräsentiert dabei einen kritischen Wert, in der Regel einen Verlust, der in Bezug auf eine vorgegebene Wahrscheinlichkeit nicht überschritten wird. Aus entscheidungstheoretischer Sicht weist der VaR jedoch einige Schwächen auf, da es sich um kein kohärentes Risikomaß handelt. Dies hat zu einer Weiterentwicklung, dem so genannten Conditional Value at Risk (CVaR), geführt. Der CVaR ist ein bedingter Erwartungswert aller unerwünschten Abweichungen vom VaR. Bei ökonomischen Anwendungen beziehungsweise Entscheidungsproblemen ist die Bestimmung eines optimalen CVaR häufig mit Schwierigkeiten verbunden. In diesem Beitrag wird auf der Grundlage von diskreten Zufallsvariablen ein gemischt-ganzzahliges lineares Programm zur Bestimmung des CVaR vorgestellt. Bei der Modellformulierung wird explizit berücksichtigt, dass der CVaR sich als eine Kombination aus den bekannten Konzepten des Fraktilkriteriums und eines Lower Partial Moment darstellen lässt. Der vorgestellte Ansatz kann beispielsweise im Portfoliomanagement bei (diskret) simulierten Renditen zur Ermittlung von optimalen Wertpapiermischungen auf Grundlage des CVaR eingesetzt werden.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 10 (see p. 57 for session)

Kraft, Holger *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*

Optimal Portfolios with Stochastic Volatility

Given a portfolio problem with stochastic volatility and an investor maximizing utility from terminal wealth with respect to a power utility function, we present a verfication result for portfolio problems with stochastic volatility. Applying this result, we solve the portfolio problem for Heston's model.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 10 (see p. 51 for session)

Mestel, Roland *(Department of Banking and Finance, University of Graz)*
Gurgul, Henryk *(Department of Applied Mathematics, University of Science and Technology, Krakow)*
Majdosz, Pawel *(High School of Economics and Computer Science, Krakow)*

Trading Volume and Stock Return Volatility

In the empirical literature on daily stock return modelling it is widely observed that return residuals do not follow a white noise process, but exhibit heteroscedasticity. This contribution is an attempt to analyze whether trading volume can be identified as one source of this ARCH effect. This is motivated by the fact that trading volume can be used as a proxy for new information arrival which is often stated to be the main reason for the conditional variance process.

Our sample contains daily data of trading volume and stock returns of the Austrian stock market from January 1997 to December 2002. Our results enhance the understanding of the relationship between trading volume, stock returns and return volatility, and therefore help to better explain the return generating process.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 10 (see p. 42 for session)

Nelissen, Franz *(GAMS Software Gmbh, Cologne)*

Mathematical Optimization in Finance: Closing the Gap

Although mathematical optimization models are considered as core elements of decision support systems in finance, their usage in practice is often limited. This is especially the case for more advanced approaches like modeling multi stage decisions and global optimization techniques for non-linear problems. Recent developments both on the solution and on the modeling side may help to improve the acceptance of these methods in practical applications.

After a brief overview of the use of optimization in finance we discuss the reasons for the limited acceptance of more advanced methods and show some solutions to overcome this situation. Nowadays financial engineers can substantially increase their productivity by taking advantage of these developments both on the algorithmic and on the modeling side.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 10 (see p. 46 for session)

Nickel, Nils-Holger *(Universität Köln)*
Derigs, Ulrich *(Universität Köln)*

Umsetzung von Muster-Portfolio-Strategien im Rentenfondsmanagement

Es wird ein Optimierungsmodell zur Umsetzung von Investmentstrategien in Form von Musterportfolios für Rentenfonds einer KAG vorgestellt, das sowohl Aspekte des aktiven und passiven Fondsmanagements kombiniert: Ein für eine Klasse von Fonds vom Management vorgegebenes Muster-Portfolio auf Titelebene ist unter Beachtung fondsspezifischer Restriktionen nachzubilden, wobei sowohl die Abweichung des Portfolios zum Muster-Portfolio, die geschätzte Überrendite zu einer spezifischen Benchmark sowie die Transaktionskosten zum jeweils aktuellen Bestandsportfolio als Zielgrößen in die Optimierung eingehen.

Die praxisnahe Formulierung des Problems führt aufgrund von Lot-Size-Bedingungen, Geld-Brief-Spannen und Provisionskosten beim Erwerb/Verkauf von Anteilen zu einem hoch-dimensionalen, diskreten Optimierungsmodell. Es wird ein mehr-phasiger Local-Search basierter Ansatz mit flexiblem Handling der Guidelines vorgestellt.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 10 (see p. 57 for session)

Seifi, Abbas *(Depart. of Industrial Engineering, Amirkabir University of Technology, Tehran)*
Hanafizadeh, Payam *(Department of Industrial Engineering, Amirkabir University of Technology, Tehran)*

Robust Portfolio Selection Using Yield Maximization

This paper presents the idea of using yield maximization as a conservative performance measure for formulating portfolio selection problems. We define a single-factor model in order to estimate the asset returns and thereby avoid the computational difficulties associated with multi-factors value-at-risk performance measure. The model assumes that the uncertain market parameters are bounded in some convex sets and only a single random variable with arbitrary distribution affects the returns. We show that the robust portfolio selection problem with this uncertainty structure can be reformulated as a secondorder cone program. Some economic motivation for the proposed formulation is also given. A double-bounded density function is used to approximate various distributions of the random parameter. The worst-case estimate of yield is computed for a tutorial example and compared with the actual yield of the optimal asset allocation using Monte Carlo simulation.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 10 (see p. 38 for session)

Straßberger, Mario *(Lehrstuhl für Allgemeine Betriebswirtschaftslehre, Universität Jena)*

How to Control Dynamically Market Risk Setting Risk Limits?

We consider the trading book of a bank to which has allocated a certain amount of risk capital. The risk capital limits the assumption of market risk within the trading book and is interpreted as market risk limit. This limit is exceeded by losses only with an accepted default probability within a given time interval. First of all in this contribution we investigate the question what time dimension such a limit should have. Instead of using any scaling method to e.g.

annualise daily limits and vice versa we argue that the convertion of limits is determined by the risk preference of the bank management. Because gain and loss is influencing the banks risk capital we next investigate how risk limits could dynamically adjusted to trading results. We propose a dynamic procedure based on ideas of portfolio insurance with synthetic put options. This has proved to be effective in terms of costs and in terms of keeping the risk limit and the given default probability.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 10 (see p. 57 for session)

Streichert, Felix *(Wilhelm-Schickard-Institut für Informatik, Universität Tübingen)*
Holger, Ulmer *(Wilhelm-Schickard-Institut für Informatik, Universität Tübingen)*

Using Hybrid Evolutionary Computation Algorithms for the Cardinality Constrained Portfolio Selection Problem

In this paper we investigate two new hybrid Evolutionary Computation (EC) Algorithms for the cardinality constrained portfolio optimization problem. The unconstrained portfolio optimization is a quadratic programming problem for which efficient algorithms exist. This is not the case for the cardinality constrained portfolio optimization problem.

The constrained portfolio optimization problem can be partitioned into two subproblems. First, a binary knapsack problem of choosing a limited number of assets from the pool of available assets. And second, a real valued allocation problem of finding the optimal weights for the selected assets. With this partition we can use two approaches to the cardinality constrained portfolio optimization problem. First, a Memetic Algorithm approach, by using a Genetic Algorithm to solve the knapsack problem in combination with a standard heuristic for the subsequent allocation problem. Second, a hybrid Evolutionary Computation Algorithm which optimizes the knapsack and the allocation problem simultaneously by using a combined binary and real valued representation for the EC individuals.

We further investigate the ability of each approach to be extended with further constraints like Buy-in Thresholds, Roundlots and Sector/Industry (joint) constraints. The hybrid EC algorithm proves to be more flexible regarding additional constraints.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 10 (see p. 46 for session)

Tasche, Dirk *(Deutsche Bundesbank)*
Theiler, Ursula *(Risk Training, Bruckmühl)*

Calculating Concentration-Sensitive Capital Charges with Conditional Value-at-Risk

By the end of 2003, the Basel committee on Banking Supervision will launch its final recommendations on minimum capital requirements in the banking industry. Although there is the intention to arrive at capital charges which concur with economic intuition, the risk weight formulas proposed by the committee will lack an adequate treatment of concentration risks in credit portfolios. The question arises whether this problem can be solved without recourse tofully-fledged portfolio models. Since recent practical experience shows that the risk measure Conditional Value-at-Risk(CVaR) is particularly well suited for detecting concentrations, we develop the granularity adjustment approach by Gordy and Wilde in the CVaR context and compare it with a semi-asymptotic approach by Emmer and Tasche. Both approaches are based on the Vasicek one-factor model which also underlies the formulas suggested by the Basel Committee.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 10 (see p. 38 for session)

Varmaz, Armin *(Lehrstuhl für ABWL, insb. Finanzwirtschaft, Universität Bremen)*
Poddig, Thorsten *(Lehrstuhl für ABWL, insb. Finanzwirtschaft, Universität Bremen)*
Oelerich, Andreas *(Lehrstuhl für ABWL, insb. Finanzwirtschaft, Universität Bremen)*

Neuerungen im Bereich der Data Envelopment Analysis und deren Einsatz im Bankensektor

Die von Charnes et al. (1978) eingeführte Data Envelopment Analysis (DEA) erlaubt die Messung von Effizienzen komplexer Produktionssysteme. In den letzten Jahren erfreute sich die Methode einer großen Beliebtheit in der akademischen Welt, so dass eine Vielzahl sowohl methodisch-theoretischer als auch anwendungsbezogener Studien publiziert wurde. Bis zum Jahr 2001 zählt das Rutgers Center for Operations Research in seiner Daten-bank weltweit über 3200 Publikationen zum Thema DEA, von denen im Zeitraum 1998-2001 über 1900 erstellt worden sind.

Dieser Beitrag hat zwei Ziele. Zum einen sollen ausgewählte aktuelle Entwicklungen im Bereich der DEA im Hinblick auf den Bankenmarkt vorgestellt werden. Zum anderen sollen diese Verfahren dann in einer praktischen Studie auf den Bereich von Genossenschaftsbanken angewendet werden, auf dem sich eine langanhaltende Fusionswelle zwecks Erreichung von kostenseitigen Größenvorteilen vollzieht. Diese Tatsache und die bisherige Vernachlässigung in Effizienzstudien macht den Bankensektor in Deutschland für die Übertragung der DEA interessant.

Angesichts der Fusionswelle sind mehrere Untersuchungsobjekte von Interesse. Unter ande-rem ist zu prüfen, ob und in welchem Umfang diese Größenvorteile existieren. Neben dieser Frage wird, mit Hilfe des von Färe et al (1989) in DEA umgesetzten und von Färe et al (1994) und Maniadakis/Thanassoulis (2000) erweiterten Malmquistindex die Effizienzänderungen der Genossenschaftsbanken im Zeitraum 1990-2001 untersucht. In Anlehnung an von Brockett et al. (1998) wird ein Effizienzvergleich von Banken auf Basis verschiedener Managementpolitiken geführt. Dabei können fusionierte und nicht fusionierte Banken im Hinblick auf deren Effizienzveränderungen vor und nach der Fusion und auch unter verschiedenen Organisationsformen wie Sparkassen und Genossenschaftsbanken verglichen werden.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 10 (see p. 57 for session)

Werner, Ralf *(RiskLab GmbH, München)*

Improvements on Michaud's Resampled Efficient Portfolios

During the last two decades, people in asset management became more and more aware that - although being a pioneering concept - classical mean-variance optimization does not lead to superior performance of optimal portfolios. One major drawback within the Markowitz framework is nowadays identified as the unreliability of the resulting optimal portfolio. This untrustworthiness is due to uncertain data, as the relevant input (mean, covariance and higher moments) has to be estimated by statistical methods. A standard concept to overcome these difficulties in practice is given by the so-called resampling procedure of efficient portfolios. Although this approach (introduced by Michaud in 1998) works quite well for some problem instances, there still exists some unsolved problems. We show, how notions from robust statistics and cluster analysis can help to improve on Michaud's procedure. We generalize his approach to both nonconvex and mixed-integer problem settings. We conclude the talk with some numerical examples showing the similarity on standard problems and the outperformance in more complex settings.

4.9 Section 9: Simulation

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 03 (see p. 47 for session)

Armenia, Stefano *(Tor Vergata University - DISP, Rome)*
Onori, Riccardo *(Tor Vergata University - DISP, Rome)*
Caramia, Massimiliano *(Tor Vergata University - DISP, Rome)*
Giannunzio, Valerio *(Tor Vergata University, Rome)*

Service Quality and Customer Abandonment: A System Dynamics Approach to Call Center Management

The ability to profitably manage the level of resources in a service system can be considered a strategic skill in all those organizations, including no-profit ones and Public Administrations, that aim at providing an added value service to customers as well as balancing the level of service (in terms of quality) with costs. In this paper we will focus on a typical service system inside of which, in every moment, management struggles in order to reach that balance, because of the extremely dynamic behavior of the entire system: a Call Center. Our aim is to show that an efficient management of the customers abandonment and the quality of service offered to customers, can positively impact on a correct resource leveling in the system, which may otherwise be found by means of typical Operations Research or Queuing Theory methods. In particular, we want to show that this can be more easily inferred and understood by resorting to simulation. After introducing some preliminary aspects by means of Queuing Theory (Erlangs formula), well first study the problem of customer abandonment (balking and reneging) by simulating a Call Center simple model by means of a process-oriented discrete-time simulation tool (Arena), and then explore a more complex model taking into account customer satisfaction an the quality of the service offered, approaching the modelling process of the system by means of System Dynamics. Results show that the level of resources can be further reduced, and that the customer (often thought as an entity external to the system) plays instead an important role on the performance of the whole system, both operationally and economically.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 03 (see p. 47 for session)

Bradl, Peter *(Forwiss, Erlangen)*

Simulation in Management

Simulation plays an important role in production. It is generally accepted that it is impossible to predict performance of a new product e.g. a car in all situations that might occur in daily use but certain behavior may be determined using simulation. Hence, corrections that are necessary after production started and which are costly and probably not possible at all may be prevented. Decisions on management level not only affect a particular product but have

influence on the standing of a whole corporation, however, simulations are still not commonly used within corporate planning. One reason might be that in product design engineers who are used to computers run the simulations, while at managment level this task has to be undertaken by for example a controller (who might be a layperson in computers). But affordable hardware and managable software are available and allow design of user oriented front ends which don't require deep knowledge of computers from the operater sometimes not even from the designer of the model. So the argument of complicacy doesn't hold any more. It seems to be lack of appropriate models and GUIs wich are the main reason for the spare use of simulation at management level.

This paper introduces models for and discusses benefits of simulation in management. The methodology used is System Dynamics (SD) because it allows to consider feedbacks within the decision (making) processes. We focus on different areas in management which we consider as important enough for most corporations Knowledge Management and derivation (and simulation/prediction) of the balance sheet. These models allow a connection to other models e.g. for production planning and support managers in their decisions. Within the paper we will describe the structure of the models and how a validation process is undertaken. Simulation runs to answer certain questions followed by an outlook will end the article.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1016 (see p. 43 for session)

Gouda, Ashraf A. *(Inst. of Mathematics, Budapest Univ. of Technology and Economics)*
Szántai, Tamás *(Inst. of Mathematics, Budapest Univ. of Technology and Economics)*

New Sampling Techniques and Variance Reduction Monte Carlo Simulation Algorithms for Dirichlet Distribution

In the lecture there will be described and compared several numerical methods for computing probabilities of Dirichlet distribution. The efficiency of the new sampling techniques as sequential conditioned sampling (SCS), sequential conditioned importance sampling (SCIS) will be compared to Crude Monte Carlo simulation method and to the variance reduction algorithm proposed by T. Szántai. Numerical test results will also be presented.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1016 (see p. 43 for session)

Grunow, Martin *(Produktionsmanagement, Technische Universität Berlin)*
Günther, Hans-Otto *(Produktionsmanagement, Technische Universität Berlin)*

Konfiguration von Anlagen der Elektronikmontage mit Hilfe objektorientierter Simulation

Zur Bestückung von Leiterplatten mit elektronischen Bauelementen werden überwiegend Automaten eingesetzt. Eine Abbildung ihres Leistungsverhaltens erfordert eine detaillierte Simulation der Maschinenkinematik. Wir stellen ein objektorientiertes Simulationssystem vor, das zur Konfiguration der Montageanlagen genutzt werden kann.

Der Modellierungsansatz weist drei Objektebenen auf: Maschinenelemente, Maschinen und Montagelinien. Alle relevanten Maschinenelemente (Bestückungskopf, Arbeitstisch, Bauelementemagazin usw.) sind einzeln in ihrem Aufbau und ihrer dynamischen Funktionsweise als Objekte des Simulationssystems modelliert. Entsprechend des konstruktiven Aufbaus der Maschinen einzelner Hersteller können diese Objekte zu Automatenmodellen kombiniert werden. Für Standardkinematiken wie Chip-Shooter, Pick-and-Place-, Collect-and-Place- und modulare Automaten sind Objekte für diese zweite Ebene bereits vorkonfiguriert. Auf der dritten Modellierungsebene können vollständige Montagelinien aus einzelnen Maschinenmodulen zusammengesetzt und weitere Elemente wie Siebdruckmaschinen oder Lötofen in das Modell aufgenommen werden.

Durch die Berücksichtigung der wesentlichen Maschinenelemente lassen sich selbst einzelne Maschinenoperationen analysieren und Engpässe innerhalb der Maschinen aufzeigen. Diese detaillierte Analyse des Leistungsverhaltens der Automaten kann bei den Maschinenherstellern für die Optimierung der Steuerung und Konstruktion der Automaten genutzt werden.

Konfigurationsentscheidungen von industriellen Betreibern von Montagesystemen zur Auswahl geeigneter Automatentypen und der Konfiguration des Gesamtsystems werden unterstützt, indem eine Leistungsanalyse unter den Bedingungen der individuellen Anwendungsumgebungen ermöglicht wird. Auch alternative Planungsverfahren können vergleichend bewertet werden, wie anhand industrieller Praxisbeispiele verdeutlicht wird.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1016 (see p. 43 for session)

Reiners, Torsten *(Technische Universität Braunschweig)*
Sassen, Imke *(Universität Magdeburg)*
Voß, Stefan *(Universität Hamburg)*

SimTool - eine Plattform zum Design interaktiver Kurse im Bereich Simulation

Auch für die Lehre im Bereich der Simulation sind virtuelle Kurse bereits in verschiedener Form realisiert worden, wobei

der thematische Schwerpunkt i.d.R. auf den Teilbereichen Zufallszahlen und Verteilungen liegt. Zunächst werden in einer vergleichenden Betrachtung verschiedene Methodiken zur Gestaltung eines unter didaktischen Aspekten qualitativ hochwertigen Kurses exemplarisch präsentiert und bewertet. Im Anschluss wird das in Java entwickelte, diskrete ereignis-orientierte Simulationswerkzeug SimTool vorgestellt, mit welchem wichtige Abläufe und Zusammenhänge didaktisch aufbereitet vermittelt werden können. Dadurch sollen problemlösende Fähigkeiten erworben und vorhandene kognitive Strukturen vertieft werden. Bei der Entwicklung standen (medien-)pädagogische Aspekte im Vordergrund: Neben einer intuitiven Bedienbarkeit waren die verschiedenen Möglichkeiten der Konfiguration in diesem Zusammenhang wesentliche Zielsetzungen. So können für Lektionen Funktionalitäten frei- bzw. abgeschaltet werden, um den Lernenden im Sinne der didaktischen Reduktion nicht bereits zu Beginn durch Komplexität zu demotivieren, sondern schrittweise an das komplexe Material heranzuführen. Während des Lernprozesses bekommt der Lernende bei Bedarf eine begleitende Unterstützung durch SIMTOOL und bleibt so auch bei der Lösung schwieriger Problemstellungen nicht auf sich selbst angewiesen. Dies wird realisiert, indem Lektionen, in denen der Lernende entsprechend zugrunde liegender Aufgabenstellungen Modelle aufbauen oder modifizieren soll, in einer XML-Skriptsprache definiert werden. Diese Lektionen beinhalten einen Mechanismus, der auf die Eingaben des Lernenden durch eine (semi-)automatische Erkennung von Problemen reagiert und ihn durch Hinweise leiten kann; z.B. kann beim Aufbau eines Modells die Verknüpfung von Bausteinen analysiert und bei falschen Entscheidungen entweder eine Mitteilung in Form eines Textfensters oder eine automatische Korrektur erfolgen.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: AW 1016 (see p. 43 for session)

Zisgen, Horst *(IBM Deutschland, Mainz)*
Meents, Ingo *(IBM Deutschland, Mainz)*
Hanschke, Thomas *(IBM Deutschland, Mainz)*
Dohse, Lars *(IBM Deutschland, Mainz)*

Integrierte Simulation mittels EPOS

Die fortwährende Anwendung von Simulationsmodellen im Geschäftsprozess der taktischen Produktionsplanung scheitert oft an der Schwierigkeit, die Modellparameter immer auf dem aktuellen Stand zu halten. Dies ist umso schwieriger desto größer die Modelle werden. Auf der anderen Seite ist aber gerade der Einsatz solcher Modellierungsmethoden bei komplexen Fertigungen mit mehreren hundert Fertigungsschritten und einer Vielzahl von Produkten umso wichtiger, da z.B. Auswirkungen von geänderten Produktionsraten und Produktportfolios nicht direkt erkennbar sind.

In diesem Beitrag wird beschrieben, wie das auf Warteschlangennetzwerken basierende Planungswerkzeug EPOS als integriertes Simulationsmodell in den Geschäftsprozess der Produktionsplanung der IBM im Bereich der Festplattenfertigung eingebettet wurde. Dabei werden die mathematischen Grundlagen, der entwickelte Geschäftsprozess sowie Erfahrungen aus der betrieblichen Praxis dargelegt.

4.10 Section 10: Continuous Optimization

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 13 (see p. 39 for session)

Belousov, Evgeny *(Moscow State University)*

On Types of Convergence of Penalty Functions Method

We consider the following convex programming problem

$$\sup\{f(x) \mid f_i(x) \leq 0,\ i = 1, \ldots, m\} \tag{1}$$

where $(-f)$ and $f_i,\ i = 1, \ldots, m$, are convex and finite-valued at each point in E_n functions. They are various classes including polynomial, weak analytic, quasianalytic ones. We approximate problem (1) by the family of unconditional extremum problem which depends on the scalar t

$$sup\{f(x) - t \cdot v(x) \mid x \in E_n\}, \tag{2}$$

where $v(x)$ are the penalty functions of various types. In this work we investigate the types of convergence for optimal sets $\Psi(t)$ of problem (2) to the optimal set ψ of original problem (1) as $t \to +\infty$; namely we give conditions which provide strong, Hausdorff, Berge or weak convergence. In particular, it is proved that if $v(x)$ is distance between a point x and feasible set of original problem (1), then the convergence is strong, i.e. $\Psi(t) = \psi$ for all sufficiently large t; if in problem (1) functions $(-f)$ and $f_i,\ i = 1, \ldots, m$ are convex weak analytic functions, then mapping $\Psi(t)$ is lower semicontinuous in the sense of Berge at $t = +\infty$.

Belousov E.G., Andronov V.G. (1995) On reducibility of the general convex programming problem to an unconditional extremumproblem. Izvestia VUZov.Matematika, 1995, No.12, 21–29.

Belousov E.G. (2000) On continuity of point-to-set mappings associated with the penalty-function method. Parametric optimization and related topics V, 2000, Peter Lang, 37–55.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 13 (see p. 39 for session)

Buss, Hinderk *(Institut für Angewandte Mathematik, Universität Heidelberg)*

Relaxation Schemes for Constrained Variational Problems in Dual Formulation

Various technical applications are most appropriately described in terms of variational inequalities, that involve elliptic differential operators. Multigrid solvers for variational problems of this type are not well established, even though hierarchically refined meshes provide a natural setting for multilevel techniques. This may be due to the fact, that there is still no satisfactory analysis of their convergence properties. The key ingredient of a multigrid solver for a constrained variational formulation is a fixed point iteration for the complementary problem, which can act as a smoother. With a view to the primal formulation the projected SOR scheme has been found useful in this capacity. In some cases, however, it may be preferable or even unavoidable to consider the dual formulation of the variational inequality. If mixed finite elements of Raviart-Thomas type are employed, a quadratic program is thus obtained, that features a saddle point structure and a complementary condition for the Lagrange multipliers. To solve the problem with a multilevel scheme a nonlinear smoother is necessary, which acts on the Lagrange multipliers. Such a smoother is derived and analysed. Under very general assumptions it is demonstrated, that this procedure constitutes a fixed point iteration. Hence, it may also be used as a stand-alone solver for the dual formulation. Its performance is discussed and a number of numerical experiments are reported.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 13 (see p. 51 for session)

Bussieck, Michael *(GAMS Development Corporation)*
Lasdon, Leon *(The University of Texas at Austin)*
Pinter, Janos *(Pinter Consulting Services, Inc., Halifax)*
Sahinidis, Nick *(University of Illinois at Urbana-Champaign)*

Global Optimization with GAMS - Applications and Performance

Mixed integer non-linear optimization problems can be formulated and solved with GAMS for more than a decade. Users of non-linear models had to cope with the limits of available local solvers. Lots of effort can go into finding a "good" starting point. Furthermore, the local solver stops at the first local optimum. Recent advances in global optimization (GO) made the introduction of three solid GO solvers into the GAMS system possible: BARON, LGO, and OQNLP. These solvers help to overcome some of the limits of local optimization. In this talk we will discuss different modeling requirements for local and global codes. We will focus on differences between the three solvers, present favored application, and compare performance.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 13 (see p. 43 for session)

Costa, João Paulo *(Faculdade de Economia Universidade de Coimbra)*
Lourenço, João *(Inst. Sup. de Cont. e Adm. de Coimbra, Instituto Politécnico de Coimbra)*

Reference Points and the Computation of Non-Dominated Solutions in MOLFP

In this communication we present a new technique to compute non-dominated solutions in multiple objective linear fractional programming (MOLFP), using reference points. Reference point methods and techniques can be considered as generalized goal programming. Their essence is that a reference point is a goal, but the sense of coming close to it does not mean the minimization of a distance, but the minimization of an achievement scalarising function (ASF). The characteristics of this function enable it to provide non-dominated solutions, even if the goals are settled below them (that is, better solutions than the settled goals if they are feasible). We developed a simple technique that computes non-dominated solutions, based in reference points, with an error that can be made as low as the user wants. We only acknowledge the existence of fairly complex non-linear methods to compute local optima that can be non-dominated solutions. The basic idea of the new technique is to divide (by the approximate middle) the non-dominate region in two partitions and to analyse each of the partitions in order to discard one of them if it can be proved that the minimum of the ASF is in the other. The process is repeated with the remaining partition. It is not always possible to discard one of the partitions and so the process must be repeated for both, building a search tree of partitions. In most problems it is only after a certain level of the search tree that we can start to discard partitions. The process will end when the remaining partitions are so little that the differences among their non-dominated solutions are lower than a pre-defined error. As we demonstrate, one partition can be discarded when the value of the ASF for its ideal point is worst than the value of the ASF of a non-dominated solution belonging to another partition not yet discarded. The results of several performed tests to the methods performance will also be presented.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 13 (see p. 39 for session)

Dempe, Stephan *(Technische Universität Bergakademie Freiberg)*
Kalashnikov, V. *(ITESM, Monterrey)*

A Mixed-Discrete Bilevel Programming Problem

Bilevel programming problems are optimization problems where a part of the variables is restricted to be an optimal solution of a second, parametric optimization problem:

$$\min_{x,y}\{F(x,y) : x \in \Psi(y),\ y \in Y\}, \qquad \text{(upper level problem)}$$

where

$$\Psi(y) = \operatorname*{Argmin}_{x}\ \{f(x,y) : g(x,y) \le 0\}. \qquad \text{(lower level problem)}$$

We discuss such problems with not identical, but related objective functions $F(x,y)$ and $f(x,y)$ in both levels. Additionally, the lower level contains one Boolean variable. If this variable has been fixed, a generalized transportation problem arises whose constraint matrix coefficients can be different from zero and one and whose objective function $f(x,y)$ represents the absolute value of a linear function. This function itself is to be minimized in the upper level problem.

This problem models a practical situation resulting from the liberalization of the gas markets. Here, cash-out values are to be determined arising if delivered amounts of gas differ from the demanded ones.

Topics discussed in the talk are the existence of optimal solutions, a solution approach and properties of the problem related to a shift of the Boolean variable from the lower to the upper level problems.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 13 (see p. 57 for session)

Dmitruk, Andrei *(Russian Academy of Sciences, Moscow)*
Kuz'kina, Natalya *(Moscow State University)*

A Refined Existence Theorem for Optimal Control Problems with Infinite Horizon

On the time interval $[0,\infty)$ we consider the problem:

$$J = s(x(0)) + \int_0^\infty \varphi(t,x,u)\,dt \ \to \min,$$

$$\dot{x} = f(t,x,u), \qquad x(0) \in M_0\,,$$
$$x(t) \in A(t), \qquad u(t) \in U(t,x(t))\,.$$

Here $x(t)$ is an $n-$vector function, absolutely continuous on each finite interval, and $u(t)$ is a measurable $r-$vector function, essentially bounded on each finite interval. The functional J is minimized over all admissible pairs at which it converges to a finite or infinite value.

Assumptions. 1) $A(t)$ is a closed set; 2) $U(t,x)$ is a convex compactum, upper semicontinuously depending on (t,x); 3) M_0 is a compact set; 4) f is affine in u and continuous in (t,x); 5) the triple f, A, U satisfies the Filippov growth condition; 6) $s(\cdot)$ is continuous; 7) φ is continuous in (t,x,u) and convex in u.

Above these assumptions, one should assume something about the behavior of the cost functional at infinity. A well known assumption is that the "tails" of the functional absolutely converge to zero uniformly over the admissible set (M.Magill, D.Carlson, A.Haurie, et al.). However, this assumption is too restrictive. A less restrictive assumption is that the family of functions $\{\varphi^-(t,x(t),u(t))\}$, where $\varphi^- = \max(0,-\varphi)$ and (x,u) ranges through all admissible set, is strongly uniformly integrable (E.Balder). This assumption is essentially weaker, but is not easily verifiable. We propose a new assumption, which is rather simple to verify and weaker than the known ones:

8) Negative parts of *sections* of the cost functional tend to zero:

$$\left(\int_{T'}^{T''} \varphi(t,x,u)\,dt\right)^- \to 0$$

as $T', T'' \to \infty$ uniformly over all admissible set.

Under assumptions 1–8 we prove that $J(x,u)$ always converges (in the above extended sense), $J(x,u) > -\infty$, and the above problem has a solution.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 13 (see p. 57 for session)

Gugat, Martin *(Fachbereich Mathematik, Technische Universität Darmstadt)*

Problems of Optimal Control in Flood Management

In active flood hazard mitigation, lateral flow withdrawal is used to reduce the impact of flood waves in rivers. Through emergency side channels, lateral outflow is generated. The optimal outflow controls the flood in such a way that the cost of the created damage is minimized.

The flow is governed by a networked system of nonlinear hyperbolic partial differential equations, coupled by algebraic node conditions. Two types of integrals appear in the objective function of the corresponding optimization problem: Boundary integrals (for example, to measure the amount of water that flows out of the system into the floodplain) and distributed integrals. For the evaluation of the derivative of the objective function, we introduce an adjoint backwards system. We present a discretized system and the corresponding discrete adjoint system, which is at the same time a discretization of the continuous adjoint system.

Numerical Examples are presented.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 13 (see p. 54 for session)

Izhutkin, Victor *(Mari State University, Yoshkar-Ola)*

Methods for Correction of Solution Nonlinear Optimization Problem with Small Data Perturbations using Reduced Direction

In many nonlinear optimization problems the initial information is known with some errors, for example the approximation of difficult relations on the basis of simple functions in the prozess of mathematical modelling to construct the criteria of optimization and constraints. Similar approximation is used to construct the numerical methods. On this reason, it is solved the problem closed to initial which can be defined as perturbed problem. It is nesessary to have the methods of quick correction of solution of nonlinear optimization problem with small perturbations of its data. Correction is a construction of approximate solution of perturbed problem adds small value to known solution of initial problem. This value has been calculated from solution of essentialy simple problem than initial (for example linear or quadratic programming). The theorie of perturbation in the mathematical programming and methods of correction of perturbed problems solutions are described in detail in [1].

In present work the modification of first and second order correction methods of perturbed problem solution is suggested based on the unified approach to construct of initial problem solution using reduced direction [2]. The simular construction of calculating procedures and program modules of perturbed and initial problems gives the possibility to define effective calculating algorithms. Numerical experiements have shown the effectivity of the suggested methods.

[1] E.S. Levitin Perturbation theory in mathematical programming and its application, 1994, Wiley.

[2] V.S. Izhutkin, M.V. Petropavlovckii, Methods of reduced directions based on differentiable penalty function for a problem of non-linear programming. Russian Mathematics (Is VUZ), 1994, Vol.38,N 12,pp.50-59

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 13 (see p. 51 for session)

Izhutkin, Victor *(Mari State University, Yoshkar-Ola)*
Bastrakova, Olga *(Mari State University, Yoshkar-Ola)*

Parallel Multimethod Technology for Solving Nonlinear Constraint Programming Problems

In the uniform scheme of methods of reduced directions feasible directions methods, methods with nondifferentiable, differentiable and barrier cost functions, as far as hybrid and multistage algorithms [1] were realized. On this basis multimethod technology [2] was offered for sequential computers.

There was performed parallel realization [3] of the methods of reduced directions, which allows to scale the problem to the number of processes.

It is suggested to solve nonlinear programming problem on high performance systems parallel with several methods. The main idea is the following:

- present number of processes is divided to subsets according to the number of used methods;
- any method solve the problem parallel scaled to the subset of its processes;
- after several iterations at the next stage of the calculation process the one point is chosen for all methods to continue the further calculations;
- the calculation process continues until necessary approximation of an optimal point has been found.

To choose the appropriate point for further calculations the Pareto - analisys is used considering the following criterias: the value of merit function and satisfication of the consraints.

[1] Izhutkin V.S., Bastrakova O.V., Four-Stage Combine Reduced Direction Method for Nonlinear Programming Problem, Abstracts of International Conference on Operations Research (OR2000), Dresden, September 2000, P. 27.

[2] Izhutkin V.S., Bastrakova O.V. Multimethod Technology for Solving Nonlinear Programming Problems, Abstracts of International Conference on Operations Research (OR2001), Duisburg, September 2001, p. 93

[3] Izhutkin V.S., Bastrakova O.V. Methods of Reduced Directions for Parallel Computers Using Binary Trees, Abstracts of International Conference on Operations Research (OR2002), Klagenfurt, September 2002.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 13 (see p. 43 for session)

Jahn, Johannes *(Universität Erlangen-Nürnberg)*
Carosi, Laura *(Universität Pisa)*
Martein, Laura *(Universität Pisa)*

Connections between Semidefinite Programming and Vector Optimization

In this talk connections between semidefinite programming and vector optimization are worked out. It is shown that well-known semidefinite programming problems are scalarized versions of a general vector optimization problem. This scalarization comprises the minimization of the trace or the maximal eigenvalue. The presented theoretical connection between semidefinite programming and vector optimization shows concrete applications in a favourable light because one can also interpret solutions of a semidefinite program as minimal matrices among a constrained set of matrices.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 13 (see p. 51 for session)

Lemarechal, Claude *(INRIA Grenoble)*
Daniilidis, A. *(University Barcelona)*
Dubost, L. *(Electricité de France)*
Gonzalez, R. *(Electricité de France)*

On a primal-proximal heuristic in combinatorial optimization. Application to unit-commitment

In 1979, D.P. Bertsekas proposed for nonlinear optimization a convexification procedure of the proximal type. We apply it to combinatorial problems.

From a theoretical point of view, this procedure can hardly be justified; it is not even guaranteed to produce a feasible point. However, it behaves remarkably well on the real-world problem of optimizing the daily production of French electricity: substantially better production schedules are obtained, and much more reliably, than with a more classical approach, based on augmented Lagrangian. Inserting this technique into EdF's unit-commitment software is currently under validation.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 13 (see p. 43 for session)

Lourenço, João *(ISCAC Instituto Politécnico de Coimbra)*
Costa, João Paulo *(FE da Univ. de Coimbra and INESC - Coimbra)*

An Interactive Weighted-Sum Algorithm for Solving Multiple Objective Linear Fractional Programming Problems

This contribution presents a new weighted sum interactive method, for helping the decision maker (DM) find the most preferred non-dominated solution in multi-objective linear fractional programming (MOLFP). Weighting vectors are used to capture the relative importance of the objective functions. The method works by progressively dividing the weighting space into smaller sub-sets. On each iteration, a chosen sub-set is characterized by both computing some representative weighting vectors, and the correspondent non-dominated solutions that maximize the aggregation of the objective functions, thus characterizing also a sub-set of the non-dominated region. The DM must choose the weighting vector whose corresponding non-dominated solution is closer to her/his preferences, in order to proceed (or the method stops if the DM is already satisfied). Based on this chosen weighting vector, and in a vector of desired improvements in the weights of the objective functions (set by the DM), the method defines new constraints in the weighting space, thus producing several smaller sub-sets. This process is repeated, until the DM finds satisfactory a particular solution. By this way, several sub-sets of the weighting space, organized in a tree structure, are generated during the evolution of the search, making possible the use of branch-and-bound techniques. This allows for both a free learning search of the non-dominated region, and a fast convergence to the most preferred non-dominated

solution. The method does not imply any rigid form of control over the DM incoherencies but rather gives her/him all the freedom necessary to the free learning search, allowing for the DM to go back and correct mistakes. Nonetheless, it can be shown that if the set of non-dominated solutions of the problem is non-empty, the interactive process can converge towards the most preferred non-dominated solution in a finite number of iterations.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 13 (see p. 54 for session)

Malek, Alaeddin *(Mathematics Department, Tarbiat Modarres University)*

Optimal Design of Wide Flange Cross Sections Based on Newton-Gradient Projection Technique

In this paper an optimal design problem of wide flange sections is first formulated as a nonlinear programming problem and solved by the Newton and gradient projection techniques. The design problem is to find the optimal values for the four continuous design variables of cross-sectional area, based on the AISC design specifications. The objective function to be minimized represents the weight of the element.

Algorithm of the new method based on the Newton-gradient projection technique is presented. Numerical results for two general examples with 13 nonlinear and linear constraints are shown. Stability of the method and smooth convergence of the optimization variables tward optimal solution are observed. This new method is independent from the starting values and in many cases show better results when we compare it with MATLAB package.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 13 (see p. 47 for session)

Mombaur, Katja D. *(Interdisz. Zentrum für Wiss. Rechnen, Universität Heidelberg)*
Bock, Hans Georg *(Interdisz. Zentrum für Wiss. Rechnen, Universität Heidelberg)*
Schlöder, Johannes P. *(Interdisz. Zentrum für Wiss. Rechnen, Universität Heidelberg)*
Longman, Richard W. *(Columbia University, New York)*

Stability Optimization of Periodic Processes with Discontinuities

Periodic solutions of optimal control problems are of interest in many areas of application, e.g. the study of cyclic economical, ecological or biological processes, the flight control of aircrafts and spacecrafts, the simulation of periodic motions in robotics etc.

We investigate general periodic processes that may have several phases, each characterized by its own set of differential equations, and discontinuities of the state variables and the right hand side between phases. Objective functions of Maier and Lagrange type as well as nonlinear constraints may be imposed on the dynamic process.

We have a developed a two-level numerical optimization method that produces stable solutions of periodic optimal control problems [1]. In the outer loop, a stability optimization is performed with the time-constant model parameters as optimization variables. Stability is measured in terms of the spectral radius of the monodromy matrix which is non-differentiable and may be non-Lipschitz at points of multiple maximum eigenvalue and involves the computation of sensitivities. In the inner loop, for the current set of parameters the solution of the optimal control problem is determined in terms of optimal control histories, cycle time and initial states.

We present the application of this method to two example problems:

1. the continuous borrower's problem (compare [2] and [3]) that describes a cyclical relationship between capital and loans
2. the discontinuous problem of determining open-loop stable periodic robot gaits [1].

[1] K. D. Mombaur, *Stability Optimization of Open-loop Controlled Walking Robots*, VDI-Fortschrittbericht, Reihe 8, No. 922 (2001).

[2] J. R. Faria and J. P. de Andrade, *Investment, Credit and Endogenous Cycle*, Journal of Economics, Vol. 67, No. 2 (1998).

[3] A. J. Novak, *A Note and Investment, Credit and Endogenous Cycle*, Essays in honor of G. Feichtinger, Springer (2000)

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 13 (see p. 39 for session)

Plyasunov, Alexander *(Sobolev Inst. of Mathematics, Novosibirsk)*

The Bilevel Optimization Problems with a Multiple-Choice Knapsack Problem on the Lower Level

In this paper we consider the following bilevel optimization problem. The upper problem is arbitrary optimization

problem. The lower problem is the linear multiple - choice knapsack problem where the right - hand sides of constraints are linear functions of the upper level variables. It is shown that the problem is well - posed if some restrictions for input data of lower problem are hold. In this case the bilevel problem can be reduced to a short sequence of one level problems. For linear bilevel problems this reduction allows us to get polynomial time algorithms.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 13 (see p. 47 for session)

Recht, Peter *(University of Dortmund)*

Redundancies in Positive-Semidefinite Quadratic Programming

The question investigated is how to detect non active restrictions in positive semidefinite quadratic programming problems:

$$\min_{x \in S} f(x) = \tfrac{1}{2} \cdot x^t C x + d^t x$$

$$\text{mit} \quad S = \{x \mid a_i^t x \leq b_i, i = 1, 2, ..., m\}$$

Here, C is a symmetric and positive-semidefinit $(n \times n)$ matrix and $d, a_i \in \mathbf{R^n}$.

If the optimization problem satisfies some regularity conditions, we can use parametric optimization techniques for that analysis. It turns out that results obtained for positive definite matrices, can be generalized to the semidefinite case. Simple calculations based exclusively on the problem data allow one to delete superfluous restrictions for this problem class during an optimization procedure.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 13 (see p. 57 for session)

Schäfer, Andreas *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*
Brandt-Pollmann, Ulrich *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*
Diehl, Moritz *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*
Bock, Hans Georg *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*
Schlöder, Johannes P. *(Interdisciplinary Center for Scientific Computing, University of Heidelberg)*

A Fast Optimal Control Algorithm with Application to Chemical Engineering

The optimal control of distillation columns is a challenging task in chemical industry. First stiffness of the model has to be handled by a suitable integrator, second sparse derivatives of the right hand sides of the model equations and sensitivities have to be computed efficiently and accurately, and third direct methods have to exploit the low number of degrees of freedom present in the discretised and parameterised problem. A new optimal control algorithm is presented, which is based on a direct multiple shooting technique for discretisation of the dynamics and parameterisation of controls. The resulting NLP will be solved by a reduced SQP method, which exploits continuity, consistency and initial conditions for constraint reduction. Therefore the number of directional derivatives per multiple shooting interval depends only on the number of controls and free parameters and not on the model dimension. In order to set up the reduced QP directional derivatives will be used, which are calculated accurately and efficiently by the principle of Internal Numerical Differentiation. Sparsity is exploited on two levels: first inside the BDF integerator and second in seed matrix compression in calculating sparse derivatives of the right hand side of model equations by algorithmic differentiation.

As an application we present the optimal control of a distillation column for separation of a binary mixture of Methanol and n-Propanol. The stiff model has 84 diff. states (concentrations, molar holdups) and 122 alg. states (liquid and vapor fluxes, temperatures). The process inputs that are available for control purpose are the heat input to the reboiler and the reflux flow rate of the condenser. The aim is to achieve a high purity of the destillate. Non-negative bounds on the fluxes out of the condenser and reboiler and fixed initial conditions are set. Results are presented which compare the computing times for one SQP iteration of the new algorithm with a classical approach where only consistency conditions are used for constraint reduction.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 13 (see p. 47 for session)

Stein, Oliver *(Rheinisch-Westfälische Technische Hochschule Aachen)*

Constraint Qualifications for Non-Smooth Optimization Problems with Applications to Design Centering

We introduce extensions of the Mangasarian-Fromovitz and the Abadie constraint qualifications to non-smooth optimization problems. We do not assume directional differentiability but only semi-continuity of the defining functions. By reviewing primal first order optimality conditions for non-smooth problems we motivate the formulations of the

constraint qualifications, we study their interrelation, and we give results on their relation to Slater's condition for non-smooth convex problems, to non-smooth reverse-convex problems, and to the stability of parametric feasible set mappings. Examples are given for problems from design centering and from robust optimization.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 13 (see p. 57 for session)

Weiss, Gideon *(Haifa University)*

Fluid Approach to Control of Multiclass Queueing Networks

We consider systems where large numbers of discrete stochastic items share joint resources over time, e.g. manufacturing, vehicle traffic, communications networks, project scheduling, economic input output systems. Our fluid approach takes 5 steps:

- Construct a Fluid Model of the system
- Formulate a Fluid Optimization Problem
- Solve Separated Continuous Linear Program (SCLP)
- Present Fluid Visualization of Optimized System
- Construct Discrete On-Line Control from the Optimal Fluid Solution.

We discuss a new simplex algorithm to solve SCLP to do step 3, and we discuss queueing systems with virtual infinite buffers, to do step 5 with bounded loss.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 13 (see p. 43 for session)

Winkler, Kristin *(Inst. of Optimization and Stochastics, University Halle-Wittenberg)*

On Geoffrions Proper Efficiency in $C(T)$

Geoffrions proper efficiency is one of the best known types of proper efficiency in the theory of multicriteria optimization. To be precise, an element $y \in R^n$ is called proper efficient (in the sense of Geoffrion) in a set $Y \subset R^n$, if there exists a constant $\delta > 0$, such that for all $y \in Y$ and each $i = 1, ..., n$ with $y_i < \bar{y}_i$ there is an index j, $1 \leq j \leq n$, with $y_j > \bar{y}_j$ and

$$\frac{\bar{y}_i - y_i}{y_j - \bar{y}_j} \leq \delta.$$

Originally defined for finite dimensional problems, this notions became generalized in different manners. The disadvantage of these generalizations was the abandonment of the componentwise comparison of the alternatives in decision.

We present a definition of Geoffrions proper efficiency in the space $C(T)$ of continuous real-valued functions on a compact set T which remains near to the original definition of Geoffrion. In the main part of the talk we will characterize Geoffrion proper efficient elements as efficient elements with respect to different cones and as solutions of scalar problems. Finally, we will relate our definition to known generalizations such as Borwein or Benson.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 13 (see p. 51 for session)

Zhadan, Vitalij *(Dorodnicyn Computing Centre of RAS, Moscow)*
Vtyurina, Marina *(Moscow Institute of Physics and Technology)*

Barrier-Projective Methods for Linear Complementarity Problem

We consider interior point methods for solving the linear complementarity problem (LCP) with a positive definite matrix. These methods are generalizations of the barrier-projective method which had been proposed for the linear programming problem [1]. We present discrete and continuous versions of the method. The continuous version is based on solving of the Cauchy problem for system of ordinary differential equations. The starting points in both spaces belong to the positive orthants. It is shown that the non-degenerate solution of the LCP is the exponentially stable position of the system. The discrete version of the method is also considered, and the problem of choosing of step lengths in the iterative process is discussed. Some properties of the proposed methods are described.

[1] Yu. Evtushenko, V. Zhadan. Stable Barrier-projection and Barrier-Newton Methods in Linear Programming. Computational Optimization and Applications 3, 1994, 289-303.

4.11 Section 11: Discrete and Combinatorial Optimization

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12a (see p. 58 for session)

Ahr, Dino *(Institute of Computer Science, University of Heidelberg)*
Reinelt, Gerhard *(Institute of Computer Science, University of Heidelberg)*

Solving the Min-Max k-Chinese Postman Problem to Optimality

Given an undirected edge-weighted graph and a depot node, the Min-Max k-Chinese Postman Problem (MM k-CPP) consists of finding $k > 1$ tours (starting and ending at the depot node) such that each edge is traversed by at least one tour and the length of the longest tour is minimized.

We will present a Branch-And-Cut approach which is based on a sparse IP-formulation of the MM k-CPP. Besides the usual parity and connectivity constraints we use a new class of constraints which is similar to the capacity constraints used in the context of the Capacitated Arc Routing Problem (CARP) and the Capacitated Vehicle Routing Problem (CVRP), respectively. We will report computational results on an extensive set of instances from the literature as well as randomly generated instances.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 14 (see p. 54 for session)

Anjos, Miguel *(University of Southampton)*

Solving the Satisfiability Problem Using Semidefinite Programming

The satisfiability (SAT) problem is a central problem in mathematical logic, computing theory, and artificial intelligence. An instance of SAT is specified by a set of boolean variables and a propositional formula in conjunctive normal form. Given such an instance, the SAT problem asks whether there is a truth assignment to the variables such that the formula is satisfied. The general SAT problem is well known to be NP-complete, although several important special cases can be solved in polynomial time. We propose semidefinite programming relaxations for the satisfiability problem within a paradigm of "higher liftings" for combinatorial optimization problems. We first discuss the ability of these relaxations to prove whether or not a given instance of SAT is satisfiable. Then, from a more practical point of view, we explore the amenability of these relaxations to practical computation.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 15 (see p. 43 for session)

Baburin, Alexei Y. *(Sobolev Inst. of Mathematics, Novosibirsk)*
Ageev, Alexander A. *(Sobolev Inst. of Mathematics, Novosibirsk)*
Gimadi, Edward *(Sobolev Inst. of Mathematics, Novosibirsk)*
Korkishko, Natalie *(Sobolev Inst. of Mathematics, Novosibirsk)*

A $3/4$-Approximation Algorithm for Finding Two Disjoint Hamiltonian Cycles of Maximum Total Weight

A complete undirected graph $G = (V, E)$ with n vertices is given. Each edge e of the graph has two weights $w_1(e)$ and $w_2(e)$. By $W_i(H)$ we denote $W_i(H) = \sum_{e \in H} w_i(e)$. The objective is to find two disjoint Hamiltonian cycles $H_1 \subset E$ and $H_2 \subset E$ having total weight $W_1(H_1) + W_2(H_2)$. Let W^* denote the optimal value. The problem arises in logistics and routing. In general the problem is NP-hard because the well known problem of existing a Hamiltonian cycle in G [see in the book The Traveling Salesman Problem and Its Variations (Eds. G. Gutin and A. Punnen), 2002] is polynomially reducible to the problem considered. We show that the problem is NP-hard when the weight functions are equal. For this case we design an $3/4$-approximation algorithm. The algorithm is based on the approach described in [Anatoly I. Serdyukov, 1984] for the symmetric MAX TSP. The idea of our algorithm (when $n = |V|$ is even) is to decompose a maximum weight spanning cubic subgraph $\widetilde{G}$ into two partial tours and extend them to disjoint Hamiltonian cycles. We observe that the weight of $\widetilde{G}$ is at least $3/4$ times the optimum W^*. Hence the algorithm achieves a performance ratio of $3/4$. The running time is $O(n^3)$ and is determined by the complexity of constructing a maximum weight degree-constrained subgraph [H.N. Gabov, 1983]. In the case of odd n we decompose a spanning subgraph $\widetilde{G}$ in which all vertices are cubic except one vertex that has degree 4.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 15 (see p. 55 for session)

Békési, József *(Faculty of Juhász Gyula Teacher's Training College, University of Szeged)*
Ahr, Dino *(Institute of Computer Science, University of Heidelberg)*
Galambos, Gábor *(Faculty of Juhász Gyula Teacher's Training College, University of Szeged)*
Oswald, Marcus *(Institute of Computer Science, University of Heidelberg)*
Reinelt, Gerhard *(Institute of Computer Science, University of Heidelberg)*

Scheduling Identical Coupled Tasks: An Exact Algorithm

The aim of the coupled task problem is to schedule n jobs each one consisting of two subtasks with required delay time between them on one machine with the objective of minimizing the makespan. This problem was analyzed in depth by Orman and Potts. They investigated the complexity of different cases depending on the lengths a_i and b_i of the two subtasks and the delay time L_i. $\mathcal{NP}$-hardness proofs or polynomial algorithms were given for all cases except for the one where $a_i = a$, $b_i = b$ and $L_i = L$. In this talk we present an exact algorithm for solving the above problem, which is linear in the number of jobs for fixed L.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12a (see p. 55 for session)

Belov, Gleb *(Technical University Dresden)*

Number of Different Patterns and Open Stacks in One-Dimensional Stock Cutting

The primary objective in cutting and packing problems is trim loss or material input minimization (in stock cutting) or value maximization (when packing into a knapsack). However, in real-life production we usually have many other objectives (costs) and constraints. Probably the most untrivial auxiliary criteria of a solution are the number of different cutting patterns (setups) and the maximal number of open stacks during cutting process. For each new pattern we need time to set up cutting equipment. Also there is a risk of mistakes when doing this. During cutting, for each started and not yet finished product we need a stack (pallet) standing around and occupying place. There are applications where this number is restricted to two. We propose an exact approach for pattern minimization and a heuristic to minimize material input while restricting number of open stacks. Further we combine both approaches. Some IP models are proposed for both problems.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 14 (see p. 47 for session)

Borndörfer, Ralf *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Löbel, Andreas *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*

Solving Duty Scheduling Problems in Public Transit

The duty scheduling problem in public transit deals with the construction of the shifts of work for the bus, tram, and subway drivers: Duty elements, i.e., units of driving work, have to be stringed into shifts conforming to a variety of labour regulations.

Duty scheduling problems can be modelled as set partitioning problems and solved by column generation algorithms. The talk considers the solution of large-scale instances with several thousands of duty elements and complex labour regulations. Such problems require special algorithmic techniques to price out large LPs, to find duties in large networks, and to construct a feasible integer solution. The talk discusses Lagrangean relaxation approaches, resource constraint shortest path computation, and primal heuristics that aim at exploiting all degrees of freedom in the problem. The methods have been implemented in an optimization system DS-OPT. Computational results for a number of real-world problems will be reported.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 15 (see p. 39 for session)

Bortfeldt, Andreas *(Fernuniversität Hagen)*

Ein genetischer Algorithmus für das zweidimensionale Strip-Packing-Problem

The talk presents a genetic algorithm (GA) for the twodimensional strip-packing problem (SPP) with rectangular shaped pieces. Both the non-guillotineable SPP and the guillotineable SPP can be tackled. The genetic algorithm has been derived from a GA that was proposed earlier for solving the container loading problem (CLP) with a single container to be loaded. The characteristic features of the earlier GA have been maintained: solutions are represented by data structures tailored to the problem at hand and specific genetic operators are used to generate offspring. In order to solve a given instance of the SPP, a sequence of CLP instances with descending container lenghts has to be solved. The GA for the SPP is subjected to a comparative test that includes some methods from other authors.

The results for well-known benchmark problems show a high performance of the GA for strongly heterogeneous sets of pieces.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 14 (see p. 39 for session)

Brieden, Andreas *(Technical University München)*

Consolidation of Farming by Means of Norm-Maximization

In the process of passing farmland to heirs a formerly large piece of land has under the heritage laws of certain countries been split over the centuries into small lots. In fact, for this and other reasons today's farmers may own a number of small sized lots that are distributed over a wide range leading to high agricultural production costs.

For various reasons classical forms of land consolidation become less and less feasible. It has hence been suggested to support the voluntary lend-lease based exchange of agricultural acreage. However, in order to fully exploit the potential of the method mathematical optimization is required.

In this talk a quadratic optimization model is presented that also intractable in theory, is successfully solved by means of a randomized approximation algorithm for Euclidean norm-maximization in practice.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 14 (see p. 51 for session)

Degenhardt, Jan *(University of Dortmund)*
Recht, Peter *(University of Dortmund)*

On Maximal Edge-Disjoint Cycle Decompositions in Graphs

The talk deals with properties of the maximal number of edge-disjoint cycles in undirected graphs. From a systematical point of view, this extremal problem has rarely been investigated up to now.

The problem will be reduced to the problem of finding a maximal cycle decomposition in Eulerian graphs. For this class of graphs sufficient conditions are proved that allow to enlarge a given decomposition. These conditions are incorporated into a local search heuristic for getting a "'good"' decomposition.

The talk relates the maximal number of edge disjoint cycles to the maximal number of elementary cycles in a graph. In this way a characterization of those graphs can be given in which the cyclomatic number and the "'cycle decomposition number"' are equal.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 14 (see p. 43 for session)

Demidenko, Vitali *(Inst. of Mathematics, Nat. Academy of Sciences of Belarus, Minsk)*

The Quadratic Assignment Problem: Reaching the Optimal Solution using Pairwise Permutation

Systems of linear inequality conditions on the elements of two real $n \times n$-matrices $A = [a_{i,j}]$ and $B = [a_{i,j}]$ are considered. They guarantee that the optimum of the quadratic assignment problem $\min\{(A, B^\sigma) | \sigma \in S_n\}$ is achieved for the given permutation σ_0. Here S_n is symmetric group, $\sigma = (\sigma(1), \sigma(2), \ldots, \sigma(n))$, $\sigma_0 = (2, 4, 6, \ldots, 5, 3, 1) \in S_n$, and (A, B^σ) is the scalar product of A and B renumbered by σ. In accordance with [Math. Program. 1998, vol. 82], matrix B is called a monotone anti-Monge matrix if it satisfies inequalities

$$b_{i,j} \leqslant b_{i,j+1}, \quad b_{i,j} \leqslant b_{i+1,j}, \quad b_{i,j-1} + b_{i-1,j} - b_{i,j} - b_{i-1,j-1} \leqslant 0$$

for all feasible i, j. The following result holds.

Theorem. *Let B be a monotone anti-Monge matrix and matrix A satisfies homogeneous system of the linear inequalities*

$$\begin{gathered} a_{i,j} - a_{n+1-i,n+1-j} \leqslant a_{n+1-i,j} - a_{i,n+1-j} \leqslant 0, \& 1 \leqslant i, j \leqslant \lfloor n/2 \rfloor; \\ a_{n-i,n-j} - a_{i,n-j} \leqslant 0,\ a_{n-j,n-i} - a_{n-j,i} \leqslant 0, \& i \neq j,\ 1 \leqslant i \leqslant \lfloor (n-1)/2 \rfloor,\ 0 \leqslant j \leqslant \lceil (n-1)/2 \rceil; \\ a_{i,j} - a_{i,n+1-j} \leqslant 0,\ a_{j,i} - a_{n+1-j,i} \leqslant 0, \& i \neq j,\ 1 \leqslant i \leqslant \lceil n/2 \rceil,\ 1 \leqslant j \leqslant \lfloor n/2 \rfloor; \\ a_{n-i,n-j} - a_{i,j} \leqslant a_{i,n-j} - a_{n-i,j} \leqslant 0, \& 1 \leqslant i,\ j \leqslant \lfloor (n-1)/2 \rfloor. \end{gathered}$$

Then σ_0 minimizes (A, B^σ) on the symmetrical group S_n.

The conditions of the theorem together which conditions included in [Math. Program. 1998, vol. 82] and their generalization presented in [Dokl. NAN Belarusi, 2003, vol. 47, N. 2] describe classes of matrices for which (A, B^σ) takes up its optimum on σ_0 and $\sigma_1 = (1, 3, 5, \ldots, 6, 4, 2)$.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 14 (see p. 39 for session)

Euler, Reinhardt *(Faculté des Sciences, Brest)*

Solving Weighted Stable Set Problems by the Simplex Method

We adapt the simplex method to solve weighted stable set problems in special classes of graphs such as grid or bipartite graphs, and report about possible extensions.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 15 (see p. 47 for session)

Fanghänel, Diana *(Technische Universität Bergakademie Freiberg)*

Regions of Stability for Nonlinear Discrete Optimization Problems

In the talk parametric discrete optimization problems of the form $\inf_x \{F(x) - p^\top x : Ax \leq b,\ x \in \mathbb{Z}^n\}$ will be discussed with parameter p and $F : \mathbb{R}^n \to \mathbb{R}$ being differentiable and convex. For this problem we will consider the regions of stability, i.e. we ask for the set $R(x^0)$ of all parameters p for which a given feasible point x^0 is optimal. Of special interest will be the conditions under which these sets are bounded or polyhedral.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 14 (see p. 43 for session)

Gassner, Elisabeth *(Graz University of Technology)*
Klinz, Bettina *(Graz University of Technology)*

A Fast Algorithm for a Parametric Assignment Problem and Applications to Max-Algebra

In the first part of this talk we consider the following parametric assignment problem (PAP): We are given a bipartite graph $G = (V, E)$ with bipartition $V = V_1 \cup V_2$ and edge set E, a subset $P \subseteq E$ and edge weights $c(i, j)$ for $(i, j) \in E$. The parametric weight $d_\lambda(i, j)$ of edge $(i, j) \in E$ is given by $c(i, j) + \lambda$ if $(i, j) \in P$ and by $c(i, j)$ otherwise. The PAP is to find an assignment (perfect matching) with maximum weight with respect to the parametric weights $d_\lambda(i, j)$ for all values of λ. In the talk we present an algorithm which solves the PAP in $O(mn + n^2 \log n)$ time for a graph with $2n$ vertices and m edges. This algorithm exploits a relationship between the PAP and a special type of parametric shortest path problem.

In the second part of the talk we show how the algorithm developed for the PAP can be extended to obtain an improved algorithm for computing the essential terms of the so-called characteristic max-polynomial of a matrix in the max-algebra. The max-algebra results from the classical linear algebra if the addition is replaced by the maximum operation and the multiplication is replaced by the real addition. The computation of the characteristic max-polynomial boils down to solving a parametric assignment problem in a complete bipartite graph. In contrast to the PAP the weights of edges in the set P are of the form $\max\{c_{ij}, \lambda\}$, i.e., nonlinear in the parameter. It turns out, however, that the PAP-algorithm can be extended to solve also this more general problem. The resulting time complexity is $O(n^3)$ for computing the characteristic max-polynomial of an $n \times n$ matrix. This improves upon the best known algorithm for this task which is due to Burkard and Butkovic (2002) by a factor of n.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12a (see p. 55 for session)

Giemsch, Peer *(Institut für Anwendungen des Operations Research, Universität Karlsruhe)*
Jellinghaus, Andreas *(Fakultät für Wirschaftswissenschaften, Universität Karlsruhe)*

Optimization Models for the Containership Stowage Problem

This paper deals with the containership stowage problem. Containers are placed on the ship in a first-in-last-out manner and therefore temporary unloading and reloading in subsequent ports along the route, called shifting, is common and results in high costs. This is true in particular if the stowage plan is based only on the stabilitiy constraints of the ship.

The generation of such plans depends on the transportation load, the technical constraints and possibilities in the ports, the ship geometry, the sequence of ports visited and some other rather technical constraints (e.g. very heavy containers or hazardous goods).

We will show how this containership stowage problem can be modeled as a mixed integer programming model and discuss the computational complexity of the problem. Based on these results, solutions methods are developed and some special cases are analyzed.

Furthermore we give some connections to other combinatorial problems like the three-dimensional packing problem with special precedence constraints or pile-up problems (e.g. Tower of Hanoi). Finally, we propose directions for further research like the use of meta-heuristics.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 15 (see p. 43 for session)

Gimadi, Edward *(Sobolev Inst. of Mathematics, Novosibirsk)*
Baburin, Alexei Y. *(Novosibirsk State University)*
Korkishko, Natalie *(Novosibirsk State University)*

An Approximation Algorithm for a Metric Problem of Finding Two Disjoint Hamiltonian Cycles of Minimum Weight

Let $G = (V, E)$ be a complete undirected graph with n vertices is given. The edges of the graph are weighted with two weight functions $w_1 : E \to R$, $w_2 : E \to R$. It is supposed that the triangle inequality holds:

$$w_1(i, j) \leq w_1(i, k) + w_1(j, k), w_2(i, j) \leq w_2(i, k) + w_2(j, k)$$

for each three vertices $i, j, k \in V$. By $W_i(H)$ we denote $W_i(H) = \sum_{e \in H} w_i(e)$. We consider a problem of finding two edge-disjoint Hamiltonian cycles $H_1 \subset E$ and $H_2 \subset E$ having minimum total weight $W_1(H_1) + W_2(H_2)$. The problem arises in logistics and routing. The problem is NP-hard even if the weight functions w_1, w_2 are equal. We construct two approximation algorithms with worst-case ratio guarantees. Both algorithms are based on construction of Hamiltonian tours by the well-known 3/2–approximation algorithm of Christofides and Serdyukov for the metric traveling salesman problem. One of the tours is transformed into a new Hamiltonian cycle which is edge-disjoint with the other tour. The main results of the talk are:

(a) The metric problem with arbitrary weight functions w_1, w_2 can be solved with a performance guarantee of $12/5$ in $O(n^3)$ running time.

(b) The metric problem with equal weight functions $w_1 = w_2$ can be solved with a performance guarantee of $9/4$ in $O(n^3)$ running time.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 15 (see p. 58 for session)

Görtz, Simon *(Bergische Universität Wuppertal)*
Klose, Andreas *(Universität St. Gallen, Institut für Operations Research der Universität Zürich)*

Solving Capacitated Facility Location Problems by Means of Branch-and-Price-and-Cut

The Capacitated Facility Location Problem (CFLP) consists of selecting plant sites from a finite set of potential sites and of allocating customer demands in such a way as to minimize operation and transportations costs. A variety of lower bounds based on Lagrangean relaxation and subgradient optimization has been proposed for this problem. In this paper, we consider an exact IP reformulation whose LP relaxation is solved by means of column generation. The value of the bound provided by the LP relaxation of the reformulated problem is equal to the value of the Lagrangean dual obtained by dualizing the demand constraints. Since the restricted master problem can get very large and multiple columns are added after each call to the pricing subproblem(s), a stabilization of the decomposition is required in order to solve the master problem exactly. To this end, a mixture of subgradient optimization and a variant of a "weighted" Dantzig-Wolfe decomposition scheme is used. For the purposes of further tightening the relaxation, we also consider the addition of polyhedral cuts, which are valid for the original problem formulation (odd hole inequalities, flow cover inequalities, and special submodular inequalities for the CFLP proposed by Aardal, Pochet and Wolsey). In order to compute optimal solutions, the above column generation procedure and cutting planes are used within a branch-and-bound-algorithm. Numerical results obtained for difficult and larger problem instances are given.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 14 (see p. 57 for session)

Gruber, Gerald *(Carinthia Tech Institute)*

Solving Large Scaled Combinatorial Optimization Problems

We consider combinatorial optimization problems with a great number of constraints. This presentation focuses on a strategy to deal with this class of problems. We report numerical results based on the solution of typical problems (e.g. maximum cut).

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 15 (see p. 43 for session)

Hernadvolgyi, Istvan *(University of Ottawa)*

Solving the Sequential Ordering Problem with Automatically Generated Lower Bounds

The Sequential Ordering Problem (SOP) is a version of the Asymmetric Traveling Salesman Problem (ATSP) where precedence constraints apply. This problem has numerous real life applications. Ascheuer et al. used a Branch&Cut technique that gives optimal or close to optimal solutions. Gambardella used a Hybrid Ant System (HAS-SOP) which provides good solutions very fast. Both of these approaches are tuned to solve the SOP problem in particular. Our approach, on the other hand, derives lower bounds automatically from the encoding of the problem and therefore could also be used to solve versions of the Traveling Salesman Problem under different constraints. In particular, we can generate lower bounds for arbitrary boolean combinations of preceding vertices – like vertices (A AND B) OR C must precede vertex D. The lower bounds are costs corresponding to optimal completions of partial tours in an automatically generated abstraction (S') of the original problem (S). Tour completion costs in S' are lower bounds of tour completions in S. In fact, the size of S' is a parameter and it is chosen so all tour completion costs in S' can be optimally determined and stored in a hash-table (pattern database) so these lower bounds are readily available when solving S. We use a novel bi-directional version of Branch&Bound and in our initial experiments for the unsolved problems we have obtained solutions within the bounds reported by previous authors and improved significantly some of the best known lower bounds. Our algorithm can also make use of additional information; in particular it can be used to refine existing solutions and can generate tighter lower bounds if it is known that certain edges must be part of the solution. Therefore it can work together with the Branch&Cut and HAS-SOP solvers. A similar approach was used by Korf to solve the Rubik's Cube optimally for the first time and by Edelkamp to derive optimal plans.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 15 (see p. 58 for session)

Ivanenko, Dmitry *(Sobolev Inst. of Mathematics, Novosibirsk)*
Plyasunov, Alexander *(Sobolev Inst. of Mathematics, Novosibirsk)*

Lower and Upper Bounds for the Bilevel Capacitated Facility Location Problem

In this paper we consider the following bilevel mixed integer programming problem. The upper problem is the capacitated facility location problem with special kind of constraints for product distribution. The lower problem is the linear knapsack problem.

Decomposition method is developed to solve the bilevel problem. The method consists of two stages. On the first stage, we design an auxiliary bilevel linear programming problem. It is shown that this problem is polynomial solvable. The optimal solution presents lower bound for original problem and is used to get upper bound on the second stage.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 14 (see p. 47 for session)

Janiak, Adam *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Lichtenstein, Maciej *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Oguz, Ceyda *(The Hong Kong Polytechnic University, Hong Kong SAR, China)*

Scheduling Multiprocessor Tasks in the Hybrid Flow Shop

The hybrid flow shop scheduling problem (HFS) is a natural generalization of the classical flow shop problem. In HFS it is assumed that at each stage of job processing there are some number of parallel processors (machines) and the job can be processed on any of them. On the other hand, the multiprocessor tasks scheduling problems overcome the limitation of classical scheduling problems, permitting job to be processed on several processors at the same time.

In this paper the problem which amalgamates both above mentioned models is considered. To be more precise, we consider the hybrid flow shop scheduling problem, in which each job is comprised of the same number of multiprocessor tasks processed at consecutive stages. The scheduling criterion is the minimization of the makespan. At first, mathematical model, some properties and the computational complexity of the considered problem are presented. The metaheuristic algorithm based on simulated annealing technique, which utilizes presented properties, is proposed. The efficiency of the proposed algorithm is verified experimentally and compared to the other algorithms which are available in the literature. Real life applications of considered problem are presented.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 14 (see p. 39 for session)

Khachiyan, Leonid *(Rutgers University, New Jersey)*
Boros, Endre *(Rutgers University, New Jersey)*
Elbassioni, Khaled *(Rutgers University, New Jersey)*
Gurvich, Vladimir *(Rutgers University, New Jersey)*

Generating Spanning Cones and Strongly Connected Digraphs

Given a set K of n polyhedral cones in R^d, let *MIN*(K) be the family of all minimal subsets X of K such that $cone(X) = R^d$, and let *MAX*(K) be the family of all maximal subsets Y of K such that $cone(Y) \neq R^d$. We

consider the problems of incrementally generating all elements of *MIN*(K) and all elements of *MAX*(K). When each cone of K is a linear subspace, the cardinality of *MAX*(K) can be bounded by a polynomial of degree $\log d$ in n and $|$*MIN*$(K)|$, and consequently all elements of *MIN*(K) can be generated in incremental quasi-polynomial time. In general, however, the generation problems for *MIN*(K) and *MAX*(K) are both NP-hard already for dihedral cones. We discuss the complexities of these two generation problems for the case where each cone in K is a ray. Kelmans and Rubinov showed that when the rays of K are in general position, the cardinality of *MAX*(K) does not exceed the cardinality of *MIN*(K) times a factor linear in n and d. This gives an efficient algorithm for generating *MIN*(K) for non-degenerate sets of rays. We argue that for generate sets of rays, *MAX*(K) can be exponentially larger than *MIN*(K). Finally, we consider two special cases of the above generation problems dealing with the generation of all minimal strongly connected subgraphs of a given digraph G, and the generation of all minimal global dicuts for G. We show that while the latter problem is NP-hard, the former can be solved efficiently.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 15 (see p. 39 for session)

Klau, Gunnar W. *(Institut für Computergraphik und Algorithmen, Technische Univ. Wien)*
Lesh, Neal *(Mitsubishi Electric Research Laboratories)*
Marks, Joe *(Mitsubishi Electric Research Laboratories)*
Mitzenmacher, Michael *(Harvard University)*

Human-Guided Search: Survey and Recent Results

We present a survey of techniques and results from the Human-Guided Search (HuGS) project, an ongoing effort to investigate interactive optimization. HuGS provides simple and general visual metaphors that allow users to guide the exploration of the search space. These metaphors apply to a wide variety of problems and combinatorial optimization algorithms, which we demonstrate by describing the HuGS toolkit and as eight diverse applications we developed using it. User experiments show that human guidance can improve the performance of powerful heuristic search algorithms. HuGS is also a valuable development environment for understanding and improving optimization algorithms: the HuGS system has been used to develop automatic algorithms that produce new best results on benchmark problem instances for two different problems.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 14 (see p. 54 for session)

Kolokolov, Alexander *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*
Kallrath, Julia *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*
Yagofarova, Darya *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

Analysis and Solving the Satisfiability Problem using L-partition

In this work we continue to study the satisfiability problem (SAT) using the integer linear programming (ILP) and L-partition approach. Early we suggested an L-class enumeration algorithm for SAT and obtained some results about L-structure of the problem [1]. Here we present a new version of this algorithm that generates a sequence S of semi-integer points from fractional covering of the ILP problem with the following properties: all these points belong to different L-classes and the sequence S is lexicographically monotonous. Unlike the general scheme of the L-class enumeration algorithm in ILP we don't solve linear programming problems. Computational experiments were carried out with DIMACS benchmark problems and random instances.

We studied also the L-structure of 2-SAT and SAT for Horn formulas and obtained as result the new proofs of polynomial solvability of these problems.

1. Kolokolov A.A., Adelshin A.V., Cheredova J.N. The L-Partition Approach To SAT And MAX SAT, Annual Conference of the GOR. Book of Abstracts. Duisburg, 2001. – P. 118.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 15 (see p. 47 for session)

Kolokolov, Alexander *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

Stability Analysis of Some Integer Programming Algorithms

The study of integer programming (IP) problems stability is an important direction in discrete optimization. Earlier [1] we have proposed an approach to investigate stability of IP problems based on regular partitions method. We are interested not only in stability of IP problems but also in the stability of algorithms for their solving. The stability of an algorithm is understood here as a condition of polynomially bounded growth of the iterations number while the relaxation sets vary insignificantly. Stability analysis of L-class enumeration algorithm and fractional dual regular cutting plane process is carried out in [2]. We established that these algorithms are stable on IP problems with closed bounded relaxation sets.

In the present paper some branch and bound algorithms (Land and Doig scheme for integer linear programming problems (ILP)) are considered. We show that these algorithms are not stable on ILP problems under small enough variations of relaxation sets. The similar result is obtained for cutting plane algorithm with Danzig cuts.

[1] Devyaterikova M.V., Kolokolov A.A. Analysis of L-structure stability of convex integer programming problems, Operations Research Proceedings. - Springer, 2000. - P. 49-54.

[2] Kolokolov A.A., Devyaterikova M.V. On stability of some integer programming algorithms, International Conference on Operations Research: Book of Abstracts. - Klagenfurt, 2002. - P. 99.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12a (see p. 55 for session)

Kolpakov, Alexander G. *(State Univ. of Telecommunications and Informatics, Novosibirsk)*
Kolpakov, Alexander-Alexandrovich *(Novosibirsk High School)*

Computational Geometry and Design of Control System for Smart Structures

The paper gives a formulation and solution of the design problem of smart (self-controlling) structure with respect to the pair {*optimal position of actuators*}{*optimal control of actuators*}, which does not decouple the problem.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 14 (see p. 43 for session)

Korkishko, Natalie *(Novosibirsk State University)*

Three-Index Axial Assignment Problem on Single-Cycle Permutations: Feasible Solutions and Approximation Algorithms

Consider a three-index axial assignment problem on single-cycle permutations. The problem is a generalization of the traveling salesman problem. The problem is NP-hard. The paper includes questions of feasible solutions, the approximation polynomial algorithms for the problem, and a probabilistic analysis of the algorithms. Let an algorithm produces the solution within relative error ϵ_n with the probability at least $1 - \delta_n$. The algorithm is asymptotically optimal if performance guarantees ϵ_n, δ_n are such that $\epsilon_n \to 0$, $\delta_n \to 0$ as $n \to \infty$.

The main topics covered include

1. the criteria of feasible solutions existence for 3-7 indexes problems,
2. the approximation algorithm with running time $O(n^2)$,
3. a probabilistic analysis of the algorithm,
4. the modification of the approximation algorithm with the $O(n^3)$ time complexity and the $\delta'_n = (\delta_n)^n$ fail probability.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 15 (see p. 51 for session)

Kozik, Andrzej *(Wroclaw University of Technology)*
Berezowski, Krzysztof S. *(Wroclaw University of Technology)*
Janiak, Adam *(Wroclaw University of Technology)*

A Survey of Optimization Problems in Automatic Leaf-Cells Synthesis Techniques for VLSI Chips Production

The growing complexity of VLSI chips results in conflicting objectives of high design quality and short turnaround time. To meet these objectives, cell-based designs are used, in which the chip is partitioned into small units called leaf-cells. Each cell is first handcrafted for performance and then stored in a cell library for reusability. Such an approach allows cell designers to concentrate on optimizing relatively small circuits, while the goal of the overall IC layout methodology is efficient placement and routing of leaf-cells. However, present-day ICs are typically partitioned into several hundreds of cell types providing families of cells with different performance/area trade-offs for the same logic function. In addition, rapid technology changes toward deep sub-micron force cell layouts to be redesigned due to new design rules. Since the latter process is complicated, error-prone and time-consuming, cell synthesis techniques that automatically convert transistor-level circuits into physical layouts are increasingly needed. Such methods must produce cell layouts of quality comparable to handcrafted cells, since it has a direct impact not only on area of the final design but also on its performance, reliability, and manufacturability.

The automatic leaf-cell synthesis is an NP-hard constrained optimization problem. The cost function could be the cell area, its critical path delay, power consumption, or a combination of these. The constraints could be cell width or height, the number of diffusion rows, the aspect ratio of the cell boundary, or the maximum size of transistors.

The leaf-cell layout optimization problems are surveyed in this paper. The survey is systematized with respect to logic styles and target layout styles. The by-product of such an approach is the possibility of presenting the chronology of the research in this area. The survey is concluded by suggesting some new open research directions in this field.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 15 (see p. 55 for session)

Krysiak, Tomasz *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Janiak, Adam *(Institute of Engineering Cybernetics, Wroclaw University of Technology)*
Kasperski, Adam *(Institute of Industrial Engineering and Management, Wroclaw University of Technology)*

Scheduling Jobs with a Stepwise Function of Change of Their Values

The paper deals with a single processor scheduling problem in which the sum of values of all the jobs is maximized. The value of job is characterized by a stepwise non-increasing function with one or more moments at which a change of job value occurs. Establishing an order of processing of datagrams which are sent by router is a practical example of application of that problem. One of the task of router is to determine the path which the datagrams will be sent farther. Each datagram includes – among other things – the field called Time To Live (TTL), which determine how long the datagram could be in the network. The value of TTL is set by sender for each datagram. However, this value is decreased in each router, proportionately to its processing time in the router. But it has to be decreased by at least 1 unit (even if the processing time is shorter than 1 second). Decreasing of the TTL value during the processing datagram by the router may be described by the non-increased stepwise function. The problem is to find such an order of processing the datagrams in the router that the sum of TTL values of these datagrams (calculated after this processing) is maximal. Beside that, we can meet this problem for example in a process of distributing and selling the commodities with a short sell-by date or in the orcharding (when we establish the order of picking of some kinds of fruits so that the total profit made on selling all fruits is maximal).

It is proved in the paper, that a special case of the considered problem – with the single common moment of the change of job value and the zero value of jobs after that moment – is NP-hard. Therefore, a pseudo-polynomially algorithm for the problem with common moments of change of job value is constructed. It is also constructed and experimentally tested a number of heuristic algorithms which solve the general version of the problem.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 15 (see p. 39 for session)

Kubitschek, Frank *(Universität der Bundeswehr Hamburg)*

Genetic Algorithm Fitness Functions for the Nesting Problem

Genetic Algorithms are well-known heuristics for the Textile Nesting Problem. Using a greedy algorithm that converts tree-formed GA individuum into layouts, we will discuss different fitness functions (convexity ratio, overall length, and time-dependent and time-independent mixtures of these).

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 14 (see p. 51 for session)

Lepin, Victor *(Inst. of Mathematics, Nat. Academy of Sciences of Belarus, Minsk)*

Approximation Algorithms for Hypergraph Layout Problems

In this paper we show that low-distortion geometric embeddings and random projection (the technique of projecting a set of points to a randomly chosen low-dimensional subspace) can be used to solve some layout problems. Specifically, for the problem of laying out a hypergraph on a 2-dimensional grid so as to minimize the total edge area, we obtain an $O(\log^3 n)$ approximation algorithm. The algorithm also works for k-dimensional versions of this problem (for any fixed k) with polylogarithmic approximation guarantees.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 14 (see p. 57 for session)

Lübbecke, Marco *(Technische Universität Berlin)*
Desrosiers, Jacques *(HEC Montreal)*
Soumis, Francois *(Ecole Polytechnique de Montreal)*
Villeneuve, Daniel *(AD OPT Technologies, Montreal)*

On Compact Formulations for Integer Programs Solved by Column Generation

Column generation has become a powerful tool in solving large scale integer programs. We argue that most of the

often reported compatibility issues between pricing oracle and branching rules disappear when branching decisions are based on the reduction of the variables of the oracle's domain. This can be generalized to branching on variables of a so-called compact formulation. We constructively show that such a formulation always exists under mild assumptions. It has a block diagonal structure with identical subproblems. Our proposal opens the way for the development of branching rules adapted to the oracle structure and the coupling constraints.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 14 (see p. 51 for session)

Montenegro, Eduardo *(Universidad Católica de Valparaíso)*

Dimension of Orbit in Graph

Of an informal way, the operation of substitution consists of replacing a vertex by a graph. This new graph is characterized through a function (of substitution) that can be autodefinible. The intention of this communication is to analyze the dimension of the orbit $wk(G)$, where each element of $wk(G)$ is obtained by substitution of each vertex of the previous element by a copy of G.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 14 (see p. 54 for session)

Naidenko, Vladimir *(Inst. of Mathematics, Nat. Academy of Sciences of Belarus, Minsk)*
Gordon, Valery *(Inst. of Mathematics, Nat. Academy of Sciences of Belarus, Minsk)*
Proth, Jean-Marie *(SAGEP Project, INRIA-Lorraine, Metz)*

On Directional Convex Hulls

Directional (restricted-orientation) convexity is a contemporary branch of geometry that has application in functional analysis, optimization, and combinatorics, as well as in more practical areas, such as VLSI design, computer graphics, image processing, geographic databases, micro-structures, motion planning, etc. We investigate OC-convexity [1] as a particular case ofdirectional convexity. It is shown that the OC-convex hull of anyfinite point set in 3-dimensional space can be constructed in apolynomial time. We established a relationship between OC-convexsets and functional directional convex sets. In particular, every compact OC-convex point set represents a functional directionally convex set provided that the orientation set is finite. This result can be used for an efficient approximate construction of functional directional convex hulls [2].

[1] V.G. Naidenko, Optimization on directionally convex sets.Operations Research Proceedings 2002. Selected Papers of theInternational Conference on Operations Research (Eds.: U.Leopold-Wildburger et al.), Klagenfurt (Austria), September 2-5,2002. Springer-Verlag, 353-358 (2002).

[2] J. Matousek and P. Plechac, On functional separately convexhulls. Discrete Comput. Geom. 19, 105-130 (1998).

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 15 (see p. 47 for session)

Nikulin, Yury *(Belarussian State University, Minsk)*

Sensitivity Analysis of Vector Discrete Optimization Problems

In optimization questions of stability (sensitivity) arise in the case when the set of feasible solutions and (or) the choice function depend on parameters, for which the area of change is known only. The presence of such parameters in optimization models is caused by inaccuracy of the initial data, non-adequacy of models to real processes, errors of numerical methods, errors of rounding off and other factors. Hence it appears important to allocate classes of problems in which small changes of input data lead to small changes of the result. The problems with such properties are called stable.

We focused our attention on a behavior of the efficient (Pareto optimal and lexicographically optimal) solutions of different multicriteria combinatorial optimization problems for the case when the parameters of these problems may vary independently.

We concentrated on describing the different types of stability of the vector Boolean quadratic programming problem and different aspects of calculating the quantitative measures of stability (stability radius). It was shown that the existence of a pseudo-polynomial method for calculating the stability radius of a lexicographic optimum implies a polynomial method to solve the problem itself. Thus we cannot evaluate the stability radius in general case for polynomial time. Despite this negative result, one may still want to calculate (approximate) the stability radius. Based on the method of z-best solutions we proposed formulas to calculate lower and upper bounds for the stability radius of a lexicographic optimum. The quality of such an approximation depends on the parameter z and grows with z.

We also introduced reasonable estimations (stability and accuracy functions) for efficient solution in a vector linear (trajectory) problem on the family of non empty subsets of a ground finite set of elements.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 14 (see p. 51 for session)

Orlovich, Yury *(Inst. of Mathematics, Nat. Academy of Sciences of Belarus, Minsk)*
Zverovich, Igor *(RUTCOR-Rutgers Center for Operations Research, Rutgers University)*

P_3-dominable Graphs

A subset $D \subseteq V$ of vertices in a simple graph $G = (V, E)$ is called *dominating* if every vertex in $V - D$ is adjacent to at least one vertex in D. The *domination number* $\gamma(G)$ of a graph G is the minimum cardinality of a dominating set in G. A class of graphs P is γ*-polynomial* if there exists a polynomial-time algorithm for calculating the domination number $\gamma(G)$ for all graphs $G \in P$. Finding a minimum dominating set in a graph G (and thus, determining $\gamma(G)$) is one of the basic algorithmic graph theory problems. Practical applications of this problem are abundant. It appears in facility location, the signal transmission analysis, the classification theory, scheduling, and the experimental design.

It is well known that generally the domination number $\gamma(G)$ of a graph G is hard to calculate. In fact, Bertossi in 1984 showed that this problem is NP-complete even for split graphs and bipartite graphs. Let P be a *hereditary*, i.e. closed under deletion of vertices, class of graphs defined by a unique forbidden induced subgraph F. Then the calculation of the domination number $\gamma(G)$ for graphs $G \in P$ is hard. In 1990 Korobitsyn proved that this problem is NP-complete unless F is obtained from an induced subgraph of the path P_4 by adding isolated vertices. However, for hereditary classes defined by several induced subgraphs the situation is not clear.

We introduce a hereditary class of P_3-dominable graphs where the problem is polynomially solvable and characterize this class by six forbidden induced subgraphs. Besides, for every γ-polynomial hereditary class P given by a finite set of minimal forbidden induced subgraphs we construct an extension P^* of P which is also a γ-polynomial hereditary class.

This research is supported by INTAS (Project INTAS 00-217).

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 14 (see p. 47 for session)

Oswald, Marcus *(Institut für Informatik, Universität Heidelberg)*
Ahr, Dino *(Institut für Informatik, Universität Heidelberg)*
Békési, József *(Juhasz Gyula Teacher's Training College,University of Szeged, Hungary)*
Galambos, Gábor *(Juhasz Gyula Teacher's Training College,University of Szeged, Hungary)*
Reinelt, Gerhard *(Institut für Informatik, Universität Heidelberg)*

Solving Coupled Task Problems to Optimality

The coupled task problem (CTP) is to schedule jobs on a single machine where each job consists of two subtasks and where the second subtask has to be started after a given time gap with respect to the first subtask. The problem has several applications and is NP-hard. We discuss an approach to solve the coupled task problem to optimality. We model the CTP as a linear 0/1-program which is the basis for a branch-and-cut algorithm. We describe the implementation of the algorithm and report about computational results.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 15 (see p. 55 for session)

Oussedik, Sofiane *(ILOG Direct)*

to be announced

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 14 (see p. 43 for session)

Paschenko, Mikhail *(Sobolev Inst. of Mathematics, Novosibirsk)*
Kochetov, Yuri *(Sobolev Inst. of Mathematics, Novosibirsk)*

A New Tabu Search Algorithm for the Generalized Assignment Problem

We propose a tabu search algorithm based on lagrangean relaxation for the generalized assignment problem. At the first stage we apply the Volume algorithm to produce lagrangean relative costs and approximation of an optimal solution for linear programming relaxation. At the second stage we use this solution to restrict the neighborhoods in the tabu search algorithm. The tabu search algorithm investigates feasible and infeasible regions. So, we propose a special kind of heuristic based on lagrangean relative costs to reconstruct infeasible solutions. Computational results for the OR-library benchmarks are discussed.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 15 (see p. 51 for session)

Pferschy, Ulrich *(University of Graz)*
Klau, Gunnar W. *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Ljubic, Ivana *(Vienna University of Technology)*
Mutzel, Petra *(Vienna University of Technology)*
Weiskircher, Rene *(Vienna University of Technology)*

The Fractional Prize-Collecting Steiner Tree Problem

The fractional prize-collecting Steiner tree problem asks for a subgraph T of a given graph $G = (V, E)$ containing a root vertex and maximizing the ratio of the vertex profits and the edge costs plus a fixed cost c_0.

$$\max_{T \subseteq G} \frac{\sum_{v \in V(T)} p(v)}{c_0 + \sum_{e \in E(T)} c(e)}$$

This problem arises e.g. in energy supply management. Our particular case was motivated by the planning problem of a district heating network where customers and connecting pipeline routes have to be selected. Motivated by the structure of real-world instances we study the special case where the underlying graph G is a tree.

We developed three algorithms based on parametric search: a binary search method, Newton's method, and a new algorithm based on Megiddo's parametric search method. We show improved bounds on the running time for the latter two algorithms. The best theoretical worst case running time, namely $O(|V| \log |V|)$, is achieved by our new algorithm. Experimental comparisons showed as a surprising result that the simple Newton method is the clear winner of the tested algorithms.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 14 (see p. 39 for session)

Pickl, Stefan *(Department of Mathematics -ZAIK- University of Cologne)*
Gebert, Jutta *(CUBIC Cologne University Bioinformatics Center - ZAIK)*
Weber, Gerhard *(METU Middle East Technology University Ankara)*
Wünschiers, Röbbe *(Department of Genetics - Cologne University Bioinformatics Center)*

Cluster Techniques, Polytopes and the Optimization of Search Strategies within the Analysis of DNA-Expression Data

The analysis of DNA-expression data is one of the main problems in computational molecular biology which leads to an application of combinatorial and algorithmic techniques. DNA chips have ignited the imagination of theorist for over a decade. The data sets we regard are taken from experiments with DNA microarray chips.

At first we present an approach to identify certain regions on the chip. This regions correlates with a certain behavior of the gene. The analysis of gene expression then leads to the information wether a gene is expressed or not and, if two different expression states of the same organism are compared, to what extend the expression of particular genes differs in both states (so called fold-change). Molecular biologists speak of gene expression patterns.

The underlying data sets of such gene expression patterns consist of time-series experiments. The range of the pixel intensity on the DNA chip is represented by the interval [1,65000]. Several algorithms were proposed to construct a certain model out of time-series data of mRNA and protein concentrations (Minimum Weight Solutions to Linear Equations MWSLE). By that approach the problem can be solved in polynomial time, if the number of genes influencing the expression of the target gene is constant (Chen et. al.) If this number is not constant (as in reality) the MWSLE is NP-complete.

The modeling approach of De Hoon et al. is based on Chen et al. They use only mRNA measurements and their approach does not need the same mentioned preconditions as the two algorithms proposed by Chen et al. De Hoon et al. determine the number and places of the nonzero parameters by the so called Akaikes Information Criterion. We present a more flexible approach which exploits strongly combinatorial information.

At the end we present a discrete approximation problem and a solution for the mixed integer problem which occurs when we restrict the solution space.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 14 (see p. 57 for session)

Stuber, Martina *(Anwendungen des Operations Research, Universität Karlsruhe)*

Combining Mathematical Programming and Constraint Logic Programming

Mathematical Programming (MP) and Constraint Logic Programming (CLP) are two alternative approaches to model

and solve optimization problems. CLP essentially provides an environment in which one can describe and solve a mixture of algebraic and logical constraints.Because of their complementary strengths, optimization and CLP can be profitably merged.

This paper deals with the approach to combine the cutting plane theory in the environment of CLP. Especially we will describe disjunctive cuts.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 14 (see p. 57 for session)

Suhl, Uwe *(Freie Universität Berlin)*

Improved Supernode Processing for Integer Programming

Supernode processing encompasses mathematical techniques to strengthen the LP-relaxation of an integer subproblem. Standard techniques are based on bound resp. coefficient reduction and cutting planes. We discuss an extended coefficient reduction as a result on probing on 0-1-variables. One result is that additional nonzero coefficients can be added to the constraint matrix (a special form of lifting) which will in general strengthen the underlying LP-relaxation. This technique has been implemented in MOPS. We present numerical results on large scale pure and mixed integer optimization problems.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12a (see p. 58 for session)

Theis, Dirk Oliver *(Institute of Computer Science, University of Heidelberg)*
Reinelt, Gerhard *(Institute of Computer Science, University of Heidelberg)*

Separation of R-Odd Cut Constraints for Routing Problems

In the IP-formulations of many arc-routing problems, so called *R-odd cut* inequalities are a basic type of constraints. The exact separation of these inequalities, for example in a Branch-and-Cut approach to the arc-routing problem, involves the computation of a minimum T-odd cut, which in turn requires (in the worst case) to perform a great number of max-flow computations. This makes the exact separation of these inequalities a bottle-neck in Branch-and-Cut algorithms.

We propose an enhanced algorithm for the miniumum T-odd cut problem with has the same asymptotic running time as those which are usually used, but, in practice, performs a *much* smaller number of max-flow computations, and, consequently, has a considerably better running time from the empirical point of view. We present computational results.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 15 (see p. 58 for session)

Velten, Sebastian *(Universität des Saarlandes, Saarbrücken)*
Hinojosa, Yolanda *(Universidad de Sevilla)*
Kalcsics, Jörg *(Universität des Saarlandes, Saarbrücken)*
Nickel, Stefan *(Universität des Saarlandes, Saarbrücken)*
Justo, Puerto *(Universidad de Sevilla)*

Heuristic Solution Methods for a Dynamic Location Model with Inventory

Today, many products of daily life have to go through a long manufacturing and distribution process before they reach customers or other final retailers. This is a result of the fact that these products often consist of many spare parts or ingredients which are produced in facilities, spread all over the world and belonging possibly to different companies. Therefore, complex manufacturing and distribution networks, named *Supply Chain Networks*, emerge.

In the talk we deal with a location problem modelling such a *Supply Chain Network* by means of establishing facilities (warehouses and plants) at two different distribution levels over a given planning horizon. The model intends to minimize the total costs for meeting demands of several products at various customer locations. Thereby, capacity limitations of the production plants and the warehouses have to be satisfied. Moreover, it is allowed to have inventory holding at the warehouses over different time periods.

The problem is addressed by a mixed integer programmimg formulation for which we present two heuristic solution approaches. On the one hand a Lagrangian relaxation based decomposition scheme is proposed whereas a heuristic procedure constructs feasible solutions for the original problem. On the other hand *Variable Neighborhood Search* is applied to the problem. In this regard two different local search routines and two different starting solutions are discussed.

The talk ends with the presentation of computational experiments which show the performance of the heuristic approaches for a wide range of problems.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 15 (see p. 51 for session)

Voß, Stefan *(Institut für Wirtschaftsinformatik, Universität Hamburg)*

On the Relationship between Geodetic and Steiner Numbers of Graphs

In this paper we study the geodetic number and the Steiner number of a graph. Given a graph G the geodetic number is the minimum cardinality of a subset S of nodes from G such that every node of G is contained in a shortest path between some pair of nodes in S. Correspondingly, the Steiner number is the minimum cardinality of a subset S of nodes from G such that every node of G is contained in some Steiner minimum tree with respect to S. We characterize some classes of graphs with respect to these numbers and proof a conjecture on the relationship between them.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12a (see p. 58 for session)

Walkowiak, Rafal *(Institute of Computing Science, Poznan University of Technology)*

Two Approaches for Optimizing the Cost of Books Dispatching

The problem originates in the multimedia dispatching company sending thousands of books, CD and videotapes to thousands of customers. It is a version of the multi-container loading problem. In general the problem consists in loading a set of rectangular boxes into a set of rectangular containers such that the shipment cost is minimized. The containers may have varying dimensions. In the shipment cost the number of packages sent to one customer and the post charge is considered. The post charge usually depends on the package weight and value and is a nonlinear function.

First optimization method proposed is based on the search for the packing scheme for a given set of boxes and containers. The choice of container is made according to first fit rule. The position of a box within a container is chosen from among a set of positions defined by the method of zones. The sequence and orientation of boxes to be packed is subsequently modified in order to search for allocation with lower shipping cost. The search is controlled by simulated annealing strategy. The above optimization method can be used with wide range of packing constraints (e.g. on weight and volume) and objective functions defining the shipment costs.

Second approach is less general and can be used only for the goods of comparably higher density. In this case there is always possible to pack (no practical volume restriction) the subset of items chosen according the weight constraint. In this case the solution of the problem consists in solving subsequently two different problems: clustering problem and single container packing problem. The first stage is a version of one-dimensional bin-packing problem with additional function for further evaluation of solutions with equal numbers of bins. Selection of an item for a given bin is constrained by its weights. The second stage is 3-dimensinal single container packing problem applied for each set of items selected in the first stage.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 15 (see p. 43 for session)

Wenger, Klaus M. *(Institute of Computer Science, University of Heidelberg)*
Reinelt, Gerhard *(Institute of Computer Science, University of Heidelberg)*

Small Instance Relaxations for the Traveling Salesman Problem

We explore Small Instance Relaxations in the branch-and-cut approach to the symmetric TSP. For small TSP instances up to 10 cities all facets of the associated polytopes are known. For seperating these facets, we shrink a given TSP support graph to a small graph with at most 10 vertices, search for a violated facet in the pool, and eventually lift it to obtain a cutting-plane. An LP relaxation tightened by cutting-planes obtained by lifting inequalities valid for small problem instances is called Small Instance Relaxation (SIR). We invest the cactus representation of the global minimum cuts of a TSP support graph for the generation of promising small graphs by shrinking. An algorithm generating all k-way cuts of a graph with weight $k\lambda/2$ where λ is the weight of a global minimum cut is presented. The TSP support graphs that we are interested in usually have many such cuts. The algorithm runs in polynomial time for fixed k. It is shown that the algorithm performs well for $k \geq 6$. We also consider near-minimum multiway cuts generated in a randomized fashion (Karger et al.) to generate small graphs. We make use of the Quadratic Assignment Problem (QAP) for the separation in the low-dimensional case. Many QAP instances have to be solved and this is the bottleneck of the SIR approach. We use a GRASP heuristic and an exact branch-and-bound procedure for the QAP. Padberg-Rinaldi criteria for shrinkable sets, graph isomorphism detection and facet class selection are applied to avoid unnecessary QAP computations. The cutting-planes we compute are facet-defining. Computational results demonstrating the potential of the SIR approach for the TSP are provided. The new results outperform the preliminary results reported in the 1990s by Christof and Reinelt. SIRs have similarities with local cuts by Applegate et al. We compare both approaches.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 15 (see p. 51 for session)

Yarosh, Alexandra *(Omsk State Service Institute)*
Kolokolov, Alexander *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

On Solving some Complex Design Problems using Discrete Optimization Models

We develop an approach to the complex product design on the basis of some discrete optimization models which may be viewed as generalizations of the MAX-SAT problem.

Consider the product constructed using elements v_j, $j = 1, \ldots, n$. Every element v_j is associated with a logical variable x_j. If v_j is included in the product then x_j takes the value *true* otherwise x_j is *false*. Assume that value s_j corresponds to element v_j, $j = 1, \ldots, n$. This value shows the importance of including its element into the product. The logical formulas C_i, $i = 1, \ldots, m$ are given which are the disjunctions of x_j and/or their negations. The "weight" of each formula is known, which defines the significance of satisfying this formula. The logical, technological and economical restrictions, lower and upper bounds on the sum of s_j for the elements included in the product are taken into account. The problem is to find the values of the logical variables which maximize the total weight of the satisfied formulas.

In this work, the integer programming models are suggested and investigated and computer experience results for some light overcoats are presented. The experiments show encouraging results.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 15 (see p. 58 for session)

Zabudsky, Gennady *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

Solving Minimax Location Problem on Plane with Forbidden Areas

We consider the problem of locating new facilities with respect to existing facilities on a plane. There are rectangular forbidden areas on the plane. The forbidden areas are isothetic rectangles, i.e., rectangles whose sides are parallel to coordinate axes. New facilities must be placed outside of the forbidden areas. Distances between the facilities are measured by the rectilinear metric. The objective is to minimize the maximum of the weighted distances between existing and new facilities and between pairs of new facilities. Two special cases of the problem are considered. We give a polynomial time algorithm for the problem with only one new facility and arbitrary number of the forbidden areas. Plane-sweep technique in connection with a novel data structure, called interval tree, are used in the algorithm [1]. We also present a mixed-integer programming model for the problem with only one forbidden area and arbitrary number of the new facilities. A heuristic procedure for solving the problem is proposed. Results of computational experiment are described.

[1] F.P. Preparata and M.I. Shamos. Computational geometry: An introduction, Springer-Verlag, New York, 1985.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12a (see p. 58 for session)

Zaozerskaya, Lidiya *(Sobolev Inst. of Mathematics, Russian Academy of Sciences, Omsk)*

A Branch and Bound Algorithm for Solving the Concave Cost Supply Management Problem

The considered problem consists in minimization of total cost of product delivery from a set of providers to several manufacturing units. A possible quantity of delivered product for each pair a provider and manufacturing unit lies between a lower bound and an upper bound or equals to zero. The supply costs are concave functions of quantity being delivered. This problem is NP-hard even in case of linear cost function and single manufacturing unit [1].

This paper proposes a branch and bound algorithm for solving the above problem that constructs the search tree according to the conditions: either some delivery is open (its quantity is more or equal to the lower bound) or prohibited (it is equal to zero). To obtain the lower bound of the function on subproblems we solve a supplementary transportation problem with a special linear cost function. Several versions of the algorithm are discussed. The results of computational experiments are presented with linear and concave cost functions.

[1] Chauhan S.S., Eremeev A.V., Kolokolov A.A., Servakh V.V. On solving concave cost supply management problem with single manufacturing unit, Proc. of Production System Design, Supply Chain Management and Logistics Conference. Miedzyzdroje, Poland, 2002. - P. 147-154.

4.12 Section 12: Applied Probability

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12 (see p. 39 for session)

Arkin, Vadim *(Central Economics and Mathematics Institute RAS, Moscow)*
Slastnikov, Alexander *(Central Economics and Mathematics Institute RAS, Moscow)*

Optimal Stopping Approach to Investment Timing Problem

In the paper it is constructed a stochastic model of investor behavior in fiscal environment in order to study the influence of depreciation policy on investment activity in the real sector. As object of investment, will be considered a project for the creation of a new industrial enterprise (firm), producing certain goods and consuming certain resources.

The important feature of considered model will be the assumption that, at any moment, the investor can either accept the project and start with the investment or delay the decision until he obtains new information on its environment (prices of the product and resources, demand etc.). The purpose of the investor is to find a moment for investment, which depends on previous environment observations, so that it maximizes expected net present value. The basic result is the obtaining an explicit formula for the dependence of optimal investment moment (rule) on parameters of the investment project and tax system. In order to derive such a formula we use a new (variational) approach to optimal stopping problem for multi-dimensional diffusion processes. This approach is based on connection between boundary problem for diffusion processes and Dirichlet problem for PDE of an elliptic type (Feynman-Kac formula). The solution of a Dirichlet problem is considered as a functional of the continuation region. An optimization of this functional on the set of all available continuation regions carries out by variational methods. Unlike the heuristic "smooth pasting" method the proposed approach allows to obtain, in principle, necessary and sufficient conditions for optimality of stopping time in a given class of continuation regions. This approach is applied to the solving an optimal stopping problem for two-dimensional geometric Brownian motion with objective functional, which is an expectation of homogeneous (of any non-negative degree) function of the process at the stopping time.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12 (see p. 55 for session)

Brandt, Manfred *(Konrad-Zuse-Zentrum für Informationstechnik Berlin)*
Brandt, Andreas *(Humboldt-University Berlin)*

On the Two-Class $M/M/1$ System under Preemptive Resume and Impatience of the Prioritized Customers

The paper deals with the two-class priority $M/M/1$ system, where the prioritized class-1 customers are served under FCFS preemptive resume discipline and may become impatient during their waiting for service with generally distributed maximal waiting times but finite expectation. The class-2 customers have no impatience. The required mean service times may depend on the class of the customer. The model is of interest in the framework of telecommunication models if one thinks of class-1 customers as time critical jobs which get lost or are routed to another system if they have to wait too long for service and of class-2 customers as less time critical jobs and if both classes of jobs are served by the same processor. As the dynamics of class-1 customers are related to the well analyzed $M/M/1 + GI$ system, our aim is to derive characteristics for class-2 customers and for the whole system. The solution of the balance equations for the partial probability generating functions of the detailed system state process is given in terms of the weak solution of a family of boundary value problems for ordinary differential equations. By means of this solution formulae for the joint occupancy distribution and for the sojourn and waiting times of class-2 customers are derived generalizing results recently obtained by Choi et al. in case of deterministic maximal waiting times. For deterministic maximal waiting times partially new explicit formulae are given.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12 (see p. 44 for session)

Dupacova, Jitka *(Department of Statistics, Charles University, Prague)*

Stochastic Programs with Decision-Dependent Probability Distributions

The basic assumption of stochastic programming models – "the probability distribution of the random element in question is known and independent of decisions" – is often not fulfilled in real-life applications. In this presentation we shall focus on problems which arise in the case of decision-dependent probability distributions. The tractability of these problems depends essentially on their structure and several favorable problem classes will be discussed, e.g.

- the probability distribution is of a known parametric form and the decisions influence only its parameters, or
- there is a finite set of probability distributions; the dependence on decisions may often be modeled by boolean variables.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12 (see p. 44 for session)

Eichhorn, Andreas *(Humboldt-University Berlin)*

Stochastic Programs and Coherent Risk Measures: Stability and Decomposition Approaches

Stochastic programs that do not only minimize expected costs but also take risk into account are of great interest in many application fields. We consider stochastic programs with coherent risk measures in the objective and study stability properties with respect to perturbations of the underlying probability distribution as well as decomposition structures. It is shown that stability of stochastic programs is closely related to certain continuity properties of the associated risk measure. Representation theorems for coherent risk measures are used to derive statements about these continuity properties for classes of coherent risk measures. Furthermore we discuss properties of these classes that are favourable for decomposition structures of stochastic programs.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12 (see p. 58 for session)

Freitag, Roman *(Vienna University of Economics and Business Administration)*
Böhm, Walter *(Vienna University of Economics and Business Administration)*

Steady State Probabilities for Queues with Total Desasters and Poisson Input Streams

We analyze a class of queueing models with Poisson input streams and total desasters and derive a general integral formula for the steady state probability by means of a renewal argument. In fact the renewal argument is not restricted on steady state analysis but can also be applied to transient analysis. The situation is particular simple in Markovian systems. We treat some special cases and give some examples.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12 (see p. 44 for session)

Kankova, Vlasta *(Inst. of Inf. Theory and Automation, Academy of Sciences, Czech Republic)*

A Remark on Multiobjective Stochastic Optimization Problems: Stability and Empirical Estimates

It happens rather often that it is reasonable to evaluate an economic activity simultaneously by several "utility" functions. If moreover, there exist a random element and a "parameter"(not determined completely but whose value must only fulfil some conditions), then a multiobjective opimization problem with a random factor usually correspond (from the mathematical point of view) to such situation. However, since mostly, the value of the parameter must be determined without knowing the random element realization, some deterministic optimization problem must be lastly assigned to the original economic problem. This deterministic problem can generally depend on the random element only through the "underlying" probability measure. Moreover, this problem can be one–objective as well as multiobjective. The talk deals with the multiobjective case. In particular, the talk deals with the case when the multiobjective problem is, generally, a system of stochastic programming problems with (the same) probability constraints.

The aim of the talk is to introduce assertions on the stability and statistical estimates of the set of (properly) efficient points. The known results for one–objective problems will be by this generalized to the (above mentioned) multiobjective case.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12 (see p. 58 for session)

Kiseleva, E. *(Depart. of Comp. Math. and Math. Cybernetics, Dnepropetrovsk National University)*
Stepanchuk, T. *(Depart. of Comp. Math. and Math. Cybernetics, Dnepropetrovsk National University)*

The optimal set partitioning method for the construction of the optimal quadrature formulae

The numerical method of simultaneous search for the optimal nodes $x_*^N = (x_1^*, \ldots, x_N^*)$ and optimal coefficients $p_1^*(x^N), \ldots, p_N^*(x^N)$ of the quadrature formulae is proposed for computing the integral $\int_\Omega f(x)dx$. The proposed method is based on reduction the problem of construction the optimal quadrature to the problem of optimal partitioning the set Ω into subsets $\Omega_1, \ldots, \Omega_N$ with the determination of the coordinates $x_1, \ldots, x_N$ of these subset centers that are coincided with the optimal nodes of the quadrature formulae as following

$$\int_\Omega \min_{i=1,\dots,N} c(x,x_i)dx \to \inf_{x^N\in\Omega\times\dots\times\Omega} \qquad (1),$$

where

$$\int_\Omega \min_{i=1,\dots,N} c(x,x_i)dx = \min_{(p_1,\dots,p_N)\in E^n} \sup_{f\in F_c} |\int_\Omega f(x)dx - \sum_{i=1}^N p_i f(x_i)|.$$

The optimal set partitioning method using the N.Z.Shors r-algorithm for the numerical solution the problem (1) with non-differentiable criterion function is applied. The algorithm of computing the Lebesque measures $\mu(\Omega_i^*(x_*^N))$ of the subsets $\Omega_1,\dots,\Omega_N$ for the determination of the optimal coefficients $p_i^*(x_*^N)$ is proposed. The main idea of the algorithm is investigation the geometry of the optimal border between subsets Ω_i^* and Ω_j^*. Proposed algorithm of finding the optimal nodes and optimal coefficients of the quadrature formulae is evaluated on a set of well-known test functions.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 12 (see p. 44 for session)

Madi-Nagy, Gergely *(Budapest University of Technology and Economics)*

Multivariate Lagrange Interpolation and its Application for Bounding Multivariate Discrete Moment Problems

We show some formulas for the difference between a multivariate function and a corresponding Lagrange interpolation polynomial. They are generalizations of the well-known univariate Newton's remainder, where the difference between the function and the Lagrange polynomial is equal to the product of a higher order divided difference of the function and differences of the variable and the base points. At certain function classes, we can ensure the nonnegativity or nonpositivity of the residual term by suitable choices of the base points of the multivariate polynomial. These results can be applied for solving multivariate discrete moment problems (MDMP's). The MDMP has been formulated as a methodology to find the minimum and/or maximum of the expected value of a function of a random vector, the support of which is a known discrete (usually finite) set. The vector has unknown probability distribution, but some of the moments are known. The moments may be binomial, power or of more general type. The problem has been initiated by Prekopa who presented it as a linear programming problem. It can be shown that finding dual feasible bases of this LP is equivalent of finding suitable base point structures on the support of the random vector for which the Lagrange remainder is nonnegative/nonpositive. That means, we can find initial basis to the dual method directly by the aid of our Lagrange interpolation results, and thus we can solve the problems more effectively. Several numerical problems related to different moment structures will be presented.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12 (see p. 55 for session)

Müller, Alfred *(Universität Karlsruhe)*
Klar, Bernhard *(Universität Karlsruhe)*

A New Class of Lifetime Distributions: The M-class

We introduce a new class of lifetime distributions exhibiting a notion of positive aging, called the M-class, which is strongly related to the well known L-class. It is shown that distributions in the M-class can not have an undesirable property recently observed in an example of an L-class distribution by Klar (2002). Moreover, it is shown how these and related classes of life distributions can be characterized by expected remaining lifetimes after a family of random times, thus extending the notion of NBUE. We give examples of M-class distributions by using simple sufficient conditions, and we derive reliability bounds for distributions in this class.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12 (see p. 39 for session)

Sass, Jörn *(Mathematics Department, University of British Columbia, Vancouver)*
Haussmann, Ulrich G. *(Mathematics Department, University of British Columbia, Vancouver)*

Portfolio Optimization under Partial Information: Parameter Estimation in a Hidden Markov Model

We consider a multi-stock market model where prices satisfy a stochastic differential equation with instantaneous rates of return modeled as an unobserved continuous time, finite state Markov chain. The investor wishes to maximize the expected utility of terminal wealth but for his investment decisions only the prices are available to him.

In Sass and Haussmann (2003) we derived an explicit representation of the optimal trading strategy in terms of the unnormalized filter of the drift process, using HMM filtering results and Malliavin calculus.

In this talk we show how stochastic volatility models can be included and discuss for constant and stochastic volatility aspects of parameter estimation, simulation, and application to historical prices.

J. Sass and U.G. Haussmann (2003): Optimizing the terminal wealth under partial information: The drift processs as a continuous time Markov chain, preprint, www.math.ubc.ca/~uhaus/

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12 (see p. 58 for session)

Schwarz, Maike *(Universität Hamburg)*

On a Queueing System with Inventory Management

We consider an M/M/1/∞-FCFS queueing system where every customer to be served also needs one unit from an associated inventory. Customers arrive according to a Poisson process. Service times and the replenishment lead time have exponential distributions. On each replenishment the inventory is filled up to its maximum size of M units. However, a replenishment order is only triggered if the inventory is empty and a customers is waiting to be served. A related system is considered by Sigman and Simchi-Levi (Annals of OR, 40, p. 371-380 (1992)).

We determine an ergodicity criterion and describe methods to numerically calculate the steady state probability distribution. Important performance measures such as the mean inventory, ordering and waiting costs will be presented. We show how to find good approximations for these performance measures which avoid intricate computations of the steady state probabilities.

A comparison with Sigman and Simchi-Levi's system shows that the average delay in queue of their system coincides with the mean waiting time of our system. This leads to a further improvement of the approximation.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12 (see p. 39 for session)

Sladky, Karel *(Institute of Information Theory and Automation, Academy of Sciences, Prague)*
Sitar, Milan *(Institute of Information Theory and Automation, Academy of Sciences, Prague)*

On the Set of Optimal Policies in Variance Penalized Markov Decision Chains

We consider a Markov decision chain with finite state and action spaces. Along with the total expected reward earned in the next transitions (i.e. the first moment of the accumulated one-stage rewards) we consider also the second moment and the variance of the accumulated rewards. At first, we focus attention on the asymptotic properties of the reward variance calculated for the sum of (undiscounted) one-stage rewards and for the accumulated rewards respectively. It can be shown that in the both cases the growth of the variance can be well approximated by a linear growth rate, called the mean variance and the mean reward variance respectively. Explicit formulas for the mean variance and the mean reward variance are obtained.

For the mean variance case and the optimality criteria considered in the literature for the mean variance tradeoff we show that, in the class of Markovian policies, optimal policies can be found in a specific set of stationary policies. This set can be constructed by an algorithmical procedure of a policy iteration type. Two numerical examples illustrate the methods and results.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 12 (see p. 55 for session)

Tijms, Henk *(Vrije University, Amsterdam)*

An Approximation for Waiting-Time Percentiles for the Finite-Capacity Multi-Server Queue

In call centers the 80-20 rule states that eighty procent of the calls should be answered in twenty seconds. To analyse the performance of call centers, a useful queueing model is the multi-server queue with Poission arrivals. Most available results deal with the infinite waiting room model, while in practice one needs results taking into account the finite number of waiting places. Except for exponential services, no analytical results are known. In this lecture we propose a simple approximation for the waiting-time probabilities in the finite-capacity model with deterministic services. Next we outline how the results for exponential services and deterministic services lead to useful approximations for the waiting-time percentiles for the case of generally distributed service times.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 12 (see p. 39 for session)

Volf, Petr *(Institute of Information Theory and Automation, Prague)*

On Random Sums and Compound Process Models in Financial Mathematics

We study random sums composed (compound) from random increments occurring at random moments. Hence,

resulting process is given by the intensity of random time moments (e.g. of the Poisson process) and by the distribution of increments. Certain versions of these processes are commonly used in insurance mathematics and connected areas for evaluation of risk processes and ruin probabilities. The objective of the present paper is to propose a model considering the compound process as a two-dimensional random point process and expressing the mutual dependence of both its components as well as their dependence on covariates, via a regression model for intensities. Namely, the multiplicative hazard regression model (Cox model) of this dependence will be preferred. We shall develop the method of estimation of model parameters and functional parts, we shall also study the methods of the prediction of process behaviour under different conditions. To this end, certain contemporary results both on random point processes models and on crossing probabilities of risk processes will be utilized. The practical application deals with the process of financial transactions and with the problem of detection of outlied (atypical) trajectories.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 12 (see p. 58 for session)

Weichbold, Josef *(Universität Linz)*
Schiefermayr, Klaus *(Universität Linz)*

Optimal Stochastic Scheduling of Two Interconnected Queues

We consider a two stage tandem queue with two parallel servers and two queues. We assume that all jobs are present at the beginning and no further arrivals take place at any time. The servers operate in parallel, so that each server can process any job. Jobs that complete service in queue 1 join queue 2 with probability p, and leave the system with probability 1-p. A job of queue 2, which has been serviced, leaves the system. The processing times are exponentially distributed. There are holding costs per job and unit time incurring for jobs holding in the system. The goal is to find the optimal preemptive (nonpreemptive) strategy such that the expected total holding costs, until the system is cleared, are minimized. We give conditions on the parameters so that we only have pure strategies and give insight in the structure of the optimal control, if there is a mixed strategy.

4.13 Section 13: Artificial Intelligence, Fuzzy Logic and Neural Networks

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: IS 0011 (see p. 44 for session)

Beck, Sebastian *(Forschungszentrum Karlsruhe / Fernuniversität Hagen)*
Mikut, Ralf *(Forschungszentrum Karlsruhe)*
Jäkel, Jens *(Forschungszentrum Karlsruhe)*

Ein entscheidungstheoretischer Ansatz zur Bewertung von Fuzzy-Regeln

Genauigkeit ist nicht unbedingt das geeignete Mittel, um die Leistungsfähigkeit von Klassifikatoren zu bewerten. Bei unterschiedlichen Kosten für Fehlklassifikationen wird der genaueste Klassifikator, der mit der niedrigsten Fehlerzahl, nicht unbedingt die niedrigsten Kosten verursachen. Liegt beispielsweise ein Kostenverhältnis für Fehlentscheidungen (Entscheidung über die Klassenzugehörigkeit ist nicht korrekt) von 10:1 bei einem Problem mit zwei Klassen vor, so ist ein Klassifikator der 10 Fehlentscheidungen der günstigeren Sorte verursacht zwar weniger genau als ein Klassifikator der nur jeweils eine Fehlentscheidung für beide Klassen trifft, letzterer verursacht allerdings höhere Kosten. Problematisch sind auch stark ungleichmäßig verteilten Klassenhäufigkeiten, bei einem Verhältnis von 99:1 erreicht ein Klassifikator, der stets die selbe Entscheidung trifft bereits eine Genauigkeit von 99%.

Eine Möglichkeit, diese Ungleichgewichte zu berücksichtigen ist der Einsatz von Algorithmen, die die unterschiedlichen Kosten der Fehlklassifikationen beim Entwurf des Klassifikators berücksichtigen. Algorithmen, die Kosten für Fehlklassifikationen und Kosten der Klassifikation selbst berücksichtigen, sind bisher wenig untersucht worden. In dem Beitrag wird ein Algorithmus zum Entwurf von Fuzzy Klassifikatoren vorgestellt, der in jeder Stufe des Entwurfsprozesses (Generierung eines Entscheidungsbaumes, Pruning von Einzelregeln und anschließendem Suchen von Regelbasen) die erwarteten Kosten des Klassifikators pro Entscheidung berücksichtigt. Zu den Kosten gehören neben denen für Fehlentscheidungen auch die Kosten, die für die eingesetzten Faktoren (Arbeit, Messgeräte usw.) zur Bereitstellung der notwendigen bei der Klassifikation verwendeten Merkmale entstehen.

Für die Bewertung von Einzelregeln und Regelbasen wird ein entscheidungstheoretischer Ansatz gewählt. Die Funktionsfähigkeit des erweiterten Algorithmus wird an einem Beispiel demonstriert.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 52 for session)

Devjak, Srečko *(Faculty of Public Administration, University of Ljubljana)*
Benčina, Joe *(Faculty of Public Administration, University of Ljubljana)*

A Multi-Criteria Prioritization of Investment Projects of a Municipality under Linguistic Information

Each year public institutions have to decide which investment projects should be realized in the next budgetary year. In

a municipality the Municipal Council is the one who has to prioritize investment projects proposed by expert personnel. The decision makers have to bear in mind some general decision criteria. The selected projects should gain reasonable level of the political support, should be accepted by the expert personnel working for the municipality and estimated by them as real and feasible and should be aligned with strategic objectives of a municipality. The decision makers are faced to a two stage multi-criteria ranking problem. We are going to present the utilisation of the linguistic approach when resolving the described problem. The solution enables a synthesis between expert and political views in regard to investment projects.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: IS 0011 (see p. 47 for session)

Drawe, Michael *(Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum)*
Werners, Brigitte *(Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum)*

Tourenplanung bei vager Nachfrage

Die Planung von Touren, die von einem Zentrallager ausgehend zur Belieferung von Kunden gefahren werden, hat das Ziel, die insgesamt zurückzulegende Entfernung zu minimieren. Dies ist besonders problematisch, wenn die Nachfrage der Kunden vorab nur vage bekannt ist und sich erst bei Auslieferung konkretisiert. Denn sobald die Lademenge nicht ausreicht, die Nachfrage vollständig zu erfüllen, sind Zusatzfahrten erforderlich, um am Zentrallager nachzuladen.

Für das vorliegende Problem werden sowohl statische als auch dynamische Modelle vorgestellt und diskutiert, wobei die Unsicherheit der Nachfrage mittels Fuzzy Sets abgebildet wird. Im statischen Modell wird die unscharfe Länge einer Tour unter Berücksichtigung unumgänglicher Zusatzfahrten bestimmt. Zur Lösung des Modells werden verschiedene heuristische Ansätze entwickelt und bewertet. Bei dynamischer Modellierung werden Zusatzfahrten antizipatorisch festgelegt. Zur Lösung wird der Einfluss der resultierenden Tourlängen auf die Bewertung der vorgestellten Heuristiken untersucht und entsprechende Modifikationen der Heuristiken vorgeschlagen.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: IS 0011 (see p. 44 for session)

Guttenberger, Siegfried *(Berufskolleg Villingen-Schwenningen)*

Die Auswahl von Produktionsmaschinen mit Hilfe eines Fuzzy-Entscheidungsunterstützungssystems

Die Entscheidungssituation in industriellen Unternehmen, und dies gilt vor allem für Zuliefererbetriebe der Automobil- und Anlagenhersteller, ist von einem hohen Maß an Unschärfe und Unsicherheit gekennzeichnet. Ein weiteres Problem für den Investor ist die Tatsache, dass die Wirkung von größeren Investitionsprojekten auf andere Unternehmensziele in einem realitätsnahen Modell nicht vernachlässigt werden darf. Der Entscheidungsträger sieht sich somit beispielsweise bei einer geplanten Anschaffung von einer CNC-Maschine über das Gewinnmaximierungsziel hinaus mit einer Mehrzielentscheidung in einer auch sonst schwierigen Entscheidungssituation konfrontiert. Die Schwierigkeit für eine Entscheidungsmodellbildung besteht nun darin, dass zwischen den gegebenen kardinal und ordinal gemessenen Zielausprägungen häufig Abhängigkeiten bestehen und diese Ziele oft nicht kompensatorisch sind. Herkömmliche Mehrzielentscheidungsmodelle sind somit nicht in der Lage, Investitionsentscheidungen in der Realität adäquat zu unterstützen und werden aus den genannten Gründen in der betrieblichen Praxis im Regelfalle auch kaum angewendet.

Im Gegensatz dazu ist die Anwendung eines regelbasierten Expertensystems auf der Grundlage von Fuzzy-Daten und dem fuzzy-logischen Schließen erfolgsversprechender. Deshalb soll anhand eines Beispiels demonstriert werden, wie mit Hilfe von verschiedenen Technologien der Fuzzy-Mengentheorie sowohl die Problematik der Unschärfe und Unsicherheit als auch die Mehrzielproblematik gehandhabt werden kann. Da beim Prozess des fuzzy-logischen Schließens ein hoher Rechenaufwand zu bewältigen ist, wurde deshalb eine Software zur Implentierung von Expertensystemen programmiert.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 52 for session)

Kaletta, Peter *(Institute of Aerospace Engineering, Technical University Dresden)*
Wolf, Klaus *(Institute of Aerospace Engineering, Technical University Dresden)*
Fischer, Andreas *(Institute for Numerical Mathematics, Technical University Dresden)*

Structural Optimization in Aircraft Engineering using Support Vector Machines for Design Classification

The main objectives in the development of future aircrafts are the reduction of manufacturing costs and structural weight. One promising way to achieve these aims is the use of fibre reinforced composite materials in primary aircraft structures.

Modelling such structures leads to a class of discrete optimization problems for which Evolutionary Algorithms are well suited. However, these algorithms require expensive computational costs, because the structural response of many design configurations has to be evaluated and each evaluation is based on a finite element code. Therefore, an efficient

approximation of the structural response is of high importance. The use of Support Vector Machines turned out to be a promising method for the classification of designs into feasible and non-feasible ones.

As an example stiffened composite panels under compressive and shear loading are considered. Thereby local and global buckling as well as strength constraints are formulated. For the decision whether these constraints are satisfied or not the Support Vector Machine is trained on geometrical data such as the height and the number of the stiffeners and material data. The latter are used in terms of the elements of the extensional stiffness, bending stiffness and extension-bending coupling stiffness matrices of skin and stiffener laminats. The results show a reasonable reduction in computational costs during the evolutionary optimization process.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 52 for session)

Kulmann, Friedhelm *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*
Rödder, Wilhelm *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*

Ein informationstheoretisches Modell assoziativer Strukturen - Anbieter und Sortimente in der Kundenwahrnehmung

Die Expertensystemshell SPIRIT ist nicht nur ein mächtiges Instrument zur unternehmerischen Entscheidungsunterstützung auf der Basis probabilistischen konditionalen Wissens, sondern unter Nutzung derselben mathematischen Prinzipien auch geeignet, kategoriale Strukturen mit ihren beschreibenden Merkmalen abzubilden. Es entstehen sogenannte informationstheoretische Netze, deren zugrunde liegende Logik es gestattet, die semantische Nähe sowohl der Kategorien untereinander als auch von Kategorien zu Merkmalen zu modellieren. Von zentraler Bedeutung ist das für die gesamte Struktur berechnete Informationsmaß, mit dem es gelingt, die Reaktion auf einen Stimulus, beispielweise die Fokussierung auf eine spezielle Kategorie, in Form eines Abrufimpulses in der Einheit [bit] zu messen. Zur Formulierung der Sachzusammenhänge bedient man sich der informationstheoretischen Konditionallogik; so wird durch das Konditional GELBE_LINIE — SCHMELZKÄSE zum Ausdruck gebracht, dass es sich bei Schmelzkäse um ein Molkereiprodukt der sogenannten Gelben Linie handelt. Wurde dieses Wissen vom Modell adaptiert, weiß es, dass es sich um einen sicheren Tatbestand handelt und jede zukünftige Wiederholung dieses Zusammenhangs nicht informativ ist (0 [bit]).

Nach einer kurzen Darstellung des Systems SPIRIT und seiner Nutzung für die Abrufimpulsmessung (vgl. hierzu [RKI 2003]) werden einige, in ihrer Struktur unterschiedliche kategoriale Beziehungen formuliert und in der Shell kausal modelliert. Im letzten Teil des Beitrags wird für ein Beispiel der Beschreibung von Warenhäusern, ihren Sortimenten und deren charakteristischen Merkmalen deutlich, dass derartige Fragestellungen gerade im Hinblick auf ihre Kundenwahrnehmung von großem Interesse sind.

[RKI 2003] Rödder, W.; Kern-Isberner, G.: From Information to Probability - An Axiomatic Approach, International Journal of Intelligent Systems, 18/4 (2003) 383-403.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: IS 0011 (see p. 47 for session)

Ramik, Jaroslav *(Silesian University, School of Business, Karvina)*

Duality in Fuzzy Linear Programming Based on Fuzzy Relations

In this paper a class of fuzzy linear programming (FLP) problems based on fuzzy relations is introduced, the concepts of feasible and satisficing solutions - the necessary tools for dealing with such problems - are defined. The class of crisp (classical) LP problems and interval LP problems can be embedded into the class of FLP ones. Moreover, for FLP problems a new concept of duality is introduced and the weak and strong duality theorems are derived. The previous results are applied to the special cases.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: IS 0011 (see p. 55 for session)

Reucher, Elmar *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*
Rödder, Wilhelm *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*

Konditionale als Mittel zur Modellierung von Zeitformen

In Erweiterung zur klassischen Aussagenlogik etablierte sich in den letzten Jahren eine probabilistische Konditionallogik, die sich der Inferenz des Prinzips Maximaler Entropie (MaxEnt) bedient [Cal91], [Roe00]. Grundlage der probabilistischen Wissensverarbeitung ist eine endliche Menge von Variablen $\mathcal{V} = \{V_1, ..., V_n\}$ mit atomaren Ausdrücken der Form *Variable* = *wert*, aus denen mittels aussagelogischer Operatoren $\wedge$, $\vee$, $\neg$ sowie $|$ beliebige (un)konditionierte Ausdrücke formulierbar sind [Roe00].

Zur Berücksichtigung temporal-logischer Aspekte finden sich in der Literatur u.a. Ansätze erweiterter Modallogiken, Intervallogiken oder Verzweigungslogiken [Kro87]. In dem vorliegenden Beitrag wird der MaxEnt - Inferenzprozeß um

temporale Elemente angereichert, die weitgehend dem menschlichen Sprachgefühl entsprechen. So kann man in dieser temporalen Logik die Zeiten Plusquamperfekt, Perfekt, Präteritum, Futur I, Futur II darstellen und bei Fortschreiten der Zeit bisher Zukünftiges in die Gegenwart überspielen. Der gesamte Ansatz basiert auf der Verwendung von Zeitkonditionalen, mit deren Aktivierung oder Inaktivierung der gesamte Zeitstrahl durchlaufen werden kann. Die Modellierung erfolgt in der Expertensystem-Shell SPIRIT, mittels derer der Zeitprozeß anhand kleinerer Beispiele demonstriert wird. Ein mittleres Beispiel mit ökonomischem Bezug zeigt die Vielfältigkeit des vorgestellten Konzepts.

[Cal91] Calabrese, P. M. (1991) Deduction and Inference Using Conditional Logic and Probability, Conditional Logic in Expert Systems, I. R. Goodman, M. M. Gupta et.al., Elsevier Science Publishers B. V.

[Kro87] Kröger, F. (1987) Temporal Logic of Programs, Springer Berlin.

[Roe00] Rödder, W. (2000) Conditional Logic and the Principle of Entropy, Artificial Intelligence, 117, 83-106.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 40 for session)

Rohde, Jens *(Techical University Darmstadt)*

Application of Neural Networks in Advanced Planning

Most Advanced Planning Systems decompose the task of production planning according to the planning horizon in two levels, mid-term and short-term planning. The mid-term planning level sets the targets for the short-term level. In response, the short-term planning level gives feedback to the mid-term level. Moreover, due to detailed knowledge, the short-term planning level should provide relevant input to the mid-term planning run. To compute accurate targets for the short-term planning level the mid-term planning should anticipate its major behaviour. In this talk we present an artificial neural network based anticipation of a short-term planning level for a single-stage, multi-product flow line production environment.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: IS 0011 (see p. 47 for session)

Schroll, Alexandra *(Otto-von-Guericke-Universität Magdeburg)*
Spengler, Thomas *(Otto-von-Guericke-Universität Magdeburg)*

Dienstplanbewertung mit unscharfen Regeln

In der Praxis der Dienstplanung wird vielfach die Forderung nach der Generierung ,,guter" Dienstpläne laut. Als ,,gut" werden solche Dienstpläne bezeichnet, die zum einen einen Beitrag zur Erfüllung der Unternehmensziele leisten und die zum anderen auf Akzeptanz der betroffenen Mitarbeiter stoßen. Sie führen u.a. zu möglichst geringen Abweichungen vom Personalbedarf (Perspektive des Unternehmens) und sehen z.B. - wenn möglich - die Gewährung geblockter freier Tage vor (Perspektive der Mitarbeiter). Da die zu erfüllenden Kriterien meist in unscharfer Form vorliegen und diese Unschärfe mit traditionellen Verfahren nicht adäquat verarbeitet werden kann, bietet es sich an, auf Fuzzy-Konzepte (insb. auf Verfahren des Fuzzy-Control zurückzugreifen. Darüber hinaus tritt bei der Bewertung der zu erfüllenden Kriterien das Problem auf, dass diese Größen in hohem Maße durch Subjektivismen geprägt sind. Dies zeigt sich beispielsweise in der unterschiedlichen Wahrnehmung und Beurteilung von Schichtmustern.

Da bereits bei relativ einfachen Problemstellungen eine Vielzahl theoretisch möglicher und zulässiger Dienstpläne existiert, erscheint eine manuelle Bewertung aller Dienstpläne kaum durchführbar. Aus diesem Grund konzentrieren sich unsere Überlegungen in dem vorliegenden Beitrag auf die Entwicklung eines unscharfen regelbasierten Systems, welches die Bewertung von Dienstplänen automatisiert und diese im Hinblick auf ihre Güte ordnet. Als Eingangsgrößen des Systems modellieren wir die linguistischen Variablen ,,Personalbedarfsdeckung" und ,,Schichtmuster" mit ihren korrespondierenden linguistischen Termen. Die resultierende Ausgangsgröße ist die Gesamtbewertung des Dienstplanes. Besonderes Augenmerk gilt neben der Modellierung des unscharfen Regelsystems der Lösung des in diesem Zusammenhang stehenden Skalierungsproblems.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: IS 0011 (see p. 44 for session)

Spengler, Thomas *(Otto-von-Guericke-Universität Magdeburg)*

Fuzzy-Szenario-Management

Seit geraumer Zeit wird verstärkt auf eine stark zunehmende Komplexität, Kontingenz und Dynamik der betrieblichen Umwelt hingewiesen, die sich u.a. in Globalisierungstendenzen der Wirtschaft, in einer rasanten Entwicklung des technischen Fortschritts sowie in Umwälzungen hinsichtlich politisch-rechtlicher und sozio-kultureller Rahmenbedingungen äußern. Die Betriebswirtschaftslehre empfiehlt, den mit solchen Entwicklungen einhergehenden Umweltturbulenzen durch strategische Planung zu begegnen, damit sich der Betrieb frühzeitig auf alternative Szenarien vorbereiten, wesentliche Chancen nutzen sowie Bedrohungen abwenden und Zukunft aktiv gestalten kann. Zu den wichtigsten Instrumenten der strategischen Planung zählt das hinlänglich bekannte Szenario-Management, dessen Ziel darin besteht,

durch die Identifikation, Analyse und Prognose wesentlicher Umweltdeskriptoren zu einer Auswahl besonders markanter Szenarien zu gelangen, die als Grundlage der sich anschließenden Strategieentwicklung, -evaluation und -auswahl herangezogen werden können. Szenario-Management kann als eine Tool-Box angesehen werden, die aus einer Vielzahl von teilweise hoch entwickelten Einzelinstrumenten besteht, zu denen (u.a.) die Vernetzungs-, die Konsistenz- und die Cross-Impact-Analyse zählen. Obwohl bei der Anwendung dieser - vor allem auf die Analyse der (Inter-)Dependenzen zwischen den Deskriptoren und deren Bündelung abzielenden Methoden - häufig eine bunte Palette von Unschärfen zu verarbeiten ist, beschränkt sich die einschlägige Literatur überwiegend auf Fälle mit scharfen Eingangsdaten und Relationen. Die vorliegende Arbeit ist deshalb der Frage gewidmet, inwieweit fuzzy Mengen und fuzzy Regeln zu einer realitätsgerechteren methodischen Stützung des Szenario-Management herangezogen werden kann.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: IS 0011 (see p. 44 for session)

Starostina, Tatiana *(Taganrog State University of Radio-Engineering)*

Using Conception of Maximal p-Partite Structure of Fuzzy Graph for Classification Problem

Usually a classification problem consists in division of the set of objects into some classes in accordance with defined classification criterion. In cases if a set of connected objects can be described by a graph, a problem of grouping of these objects can be represented as a problem of search for p-partite structure in given graph. Sometimes connections between objects cannot be given precisely. Then a graph, describing this problem will be fuzzy and classification problem will consist in the search for fuzzy p-partite structure in initial fuzzy graph. Object grouping criteria can be various. For example, a number of objects in classes should be equal or approximately equal; a common weight of connections between objects of the same class should be maximal or minimal. In this case a criterion of division of objects into classes be a maximal p-partite degree. Then a classification problem consists in allocation of such p-partite structure in the graph, for which a suggested p-partite degree will be maximal.

Calculated p-partite degrees of all fuzzy p-partite structures of fuzzy graph can be possible to find maximal p-partite degree of fuzzy graph. The p-partite structures, corresponding to this maximal degree, will be presented as a decision or as a set of decision of considered classification problem. Some properties of fuzzy p-partite structure and estimations of p-partite degree of fuzzy graph will be given also in paper. Since a number of all p-partite structures in fuzzy graph depends on the number of vertices and it's very large, then it would be advisably to develop an algorithm, which will find maximal p-partite structure in fuzzy graph quickly. A conception of p-partite degree of fuzzy graph and an algorithm of search of maximal p-partite structure allows to find p classes in the set of considered objects. It can be useful e.g. on the preparatory stage of solution of matching or transportation problems if it is required to group homogeneous objects.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: IS 0011 (see p. 55 for session)

Topaloglu, Seyda *(Department of Industrial Engineering, Dokuz Eylul University)*
Ozkarahan, Irem *(Department of Industrial Engineering, Dokuz Eylul University)*

Comparison of Different Search Heuristics Proposed for a Constraint-Based Solution Approach to the Job Sequencing Problem

The job sequencing problem for a single machine with sequence dependent setups was first modeled and solved with a constraint programming approach in Carsten and Drexl (1995), and the performance of mixed integer programming (MIP) and constraint programming (CP) solvers were compared for a number of test problems. This study extends the previous work by devising ten different solution strategies for the tree search process of the CP approach in order to analyze its behavior under differing variable and value ordering heuristics. Some of the search heuristics rely on a hybrid solver strategy which uses the linear programming solver in the tree search process of CP. For instance, an optimal solution to the relaxed MIP model at each node of the search tree is used in order to decide on which variable to choose next and on what value to branch on next. These strategies can only be applied on an integrated model that consists of a combination of MIP and CP models with linking constraints that provide transformation of information between the models. Others exploit problem specific information such as setup cost and due date, or conduct nested search to guide the search process. The MIP, CP, and integrated MIP/CP models are all coded in the OPL language and solved through CPLEX and Solver engines of ILOG OPL Studio that uses the branch-and-bound technique for MIP and constraint solving algorithms for CP respectively. A comparative analysis of the performance of the proposed search heuristics is made with respect to solution times obtained for an extended problem set of the previous study, and the behavior of the CP and MIP solvers are investigated for differing problem characteristics.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 52 for session)

Ulmer, Holger *(Center for Bioinformatics Tübingen, University of Tübingen)*
Streichert, Felix *(Center for Bioinformatics Tübingen, University of Tübingen)*
Zell, Andreas *(Center for Bioinformatics Tübingen, University of Tübingen)*

Optimization by Gaussian Processes Assisted Evolution Strategies

Evolution Strategies are known to be excellent optimization tools for complex high-dimensional multimodal real-valued

problems. However, they require a very large number of problem function evaluations. In many real world applications, like high throughput material science or design optimization, a single fitness evaluation is very expensive or time consuming. Therefore, standard evolutionary computation methods are not practical for such applications. Applying models as a surrogate of the real fitness function is a quite popular approach to handle this restriction. We propose a new model assisted Evolution Strategy (MAES), which uses a Gaussian Process (GP) approximation model. The purpose of the Gaussian Process model is to preselect the most promising solutions, which are then actually evaluated by the real problem function. To refine the preselection process the likelihood of each individual to improve the overall best found solution is determined. Therefore, not only the model prediction but also the model confidence provided by the GP is used additional. Due to this, the new GP MAES algorithm has a much better convergence behavior and achieves better results than standard evolutionary optimization approaches with less fitness evaluations. Numerical results from extensive simulations on several high dimensional test functions and one material optimization problem are presented.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 40 for session)

Zhang, Kejing *(Universität Karlsruhe)*
Geldermann, Jutta *(Universität Karlsruhe)*
Rentz, Otto *(Universität Karlsruhe)*

The Neural Network Based Integrated Multi-Criteria Decision Support System

The paper seeks to tackle the problem that different Multi-Attribute decision making methodologies often deliver different results. A neural network based multi-criteria decision support system is developed. The system integrates a group of multi-criteria decision techniques, including classical MAUT methods and Outranking models. The neural network is used to analyse the decision results from different approaches and further suggest a suitable method for a specific decision situation.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 40 for session)

Zimmermann, Hans-Georg *(Siemens AG Corporate Technology)*
Grothmann, Ralph *(Siemens AG Corporate Technology)*
Tietz, Christoph *(Siemens AG Corporate Technology)*

Cognitive Agents with Utility Functions

We present a new approach of modeling the decision behavior of market participants. The decision making of such an economic agent is modeled with a homeostatic dynamic system. Homestasis means, that the system maintains an internal equilibrium. On this basis, we derive the properties perception, internal processing and action of a cognitive system. As a structural representation of homeostasis, we propose so-called zero-neurons within a time-delay recurrent neural network.

As an extension to this concept of agent modeling, we integrate a utility function into the cognitive system. By this well known micro economical concept, we are able to explain the decision behavior of an agent by a detailed analysis of his long-term objectives.

A natural way of explaining and predicting market prices is to analyze the decision making of many agents on the microeconomic level and to study their interaction on the macroeconomic side of the market (i.e. price formation mechanism). The aggregation of agents trading decisions leads to a multi-agent based approach of market modeling.

Merging the economic theory of multi-agent market modeling with neural networks, our models concern semantic specifications instead of being limited to ad-hoc functional relationships. As an advantage, our multi-agent models allow the fitting of real world financial data. In an empirical study of the Dollar - Euro foreign exchange market, it turns out that our approaches are superior to a traditional econometric forecasting techniques.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: IS 0011 (see p. 40 for session)

Zimmermann, Hans-Georg *(Siemens AG Corporate Technology)*
Tietz, Christoph *(Siemens AG Corporate Technology)*
Grothmann, Ralph *(Siemens AG Corporate Technology)*

Model Based Feature Selection by Neural Networks

Feature selection is the task of selecting inputs out of a larger set that have the highest explanatory or predictive power given a certain outcome. The primary objective of feature selection is to improve the performance of the model. Additionally, the feature selection provides a better understanding of the underlying system that generated the data. Thus, feature selection from data is of general interest. Applications of feature selection can be found e.g. in time series prediction, regression or classification tasks.

We deal with feature selection techniques that are based on feedforward neural networks. First, we show how to build a neural network model form the data. Relevant questions in this section are the handling of errors in the inputs and how to overcome the dependence of the model building from the network initialization by random numbers. Second, we rank the input variables of the model and select the most relevant features. In this connection, the key question is the development of optimal ranking factors. We present two test criteria, the so-called output and input test. Third, we define and compare constructive and destructive pruning methods.

The usefulness of our feature selection techniques is illustrated by a real world application: Concerning a manufacturing process we select features that have the highest power to optimize the production line.

4.14 Section 14: Econometrics, Statistics, Mathematical Economics and Decision Theory

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 03 (see p. 52 for session)

Brandt-Pollmann, Ulrich *(Interdisciplinary Center for Scientific Computing, Heidelberg)*
Winkler, Ralph *(Interdisciplinary Center for Environmental Economics, Heidelberg)*
Moslener, Ulf *(Interdisciplinary Center for Environmental Economics, Heidelberg)*

Time Lags in Capital Accumulation

All production takes time. That is, the transformation of inputs into outputs does not occur instantaneously. However, the common neoclassical theory abstracts from the time structure of the production process and usually assumes that inputs are transformed into outputs *infinitely fast*.

We pose the question of the quality of this approximation. *A priori* it is not clear in how far the resulting optimal path differs from the "real" optimal path *quantitatively* or even *qualitatively*. To answer this question we formulate a basic optimal control capital accumulation model. Similar to the *time to build* models in the macroeconomic real business cycle theory we introduce an exogenously given time lag between the assignment of inputs and the availability of the outputs, the *investment period* [Kydland, Prescott] . Hence, the dynamics of our capital accumulation model is governed by a system of *functional differential equations*. Optimal investment paths for a finite investment period are shown to be cyclic as opposed to the monotonic paths for instantaneous production.

Furthermore, we present a systematic analysis of the impact of the length of the investment period by numerical investigations. We show how to reformulate the retarded functional differential equation in a suitable way so that sophisticated numerical methods for optimal control can be applied. Optimal paths of capital and investment for different lengths of the investment period for the resulting highdimensional optimal control problem are determined by the advanced package MUSCOD-II [Leineweber et al.]. It turns out that both the frequency and the amplitude of the cycles depend on the length of the investment period.

F.E. Kydland,E.C. Prescott: Time to built and aggregate fluctuations, Econometrica,**50** 1345-70, (1982).

D.B. Leineweber, I. Bauer, H.G. Bock, J.P. Schlöder, An efficient multiple shooting based reduced SQP strategy for large-scale dynamic process optimization - part I: theoretical aspects. Comput. Chem. Engng. **27** 157-166, (2003).

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 03 (see p. 40 for session)

Brosche, Carmen *(Lehrst. f. Wirtschafts- u. Sozialstatistik, Friedrich-Schiller-Universität Jena)*

Testen kausaler Effekte

Bei der Untersuchung kausaler Effekte wird der Einfluss verschiedener Behandlungen (Treatments) von Merkmalsträgern auf die Ausprägungen einer Variablen (Responsevariablen) untersucht. Da jedem Merkmalsträger nur ein Treatment zugewiesen werden kann, ist es nicht möglich, individuelle oder durchschnittliche kausale Effekte direkt aus vorliegenden Beobachtungen zu bestimmen. Bei der Ermittlung kausaler Effekte müssen deshalb unbeobachtete Werte Berücksichtigung finden. Bei Gültigkeit einer Ignorability genannten Voraussetzung für den Zuweisungsmechanismus der Treatments zu den Merkmalsträgern und der Annahme eines konstanten additiven individuellen kausalen Effektes stellt Rubin (1974,1990) einen auf Fisher (1935) basierenden Test für die Nullhypothese: "'Der individuelle kausale Effekt ist 0"', vor. Die unter der Nullhypothese vollständig bekannten Werte der Responsevariablen und das bekannte Zuweisungsdesign ermöglichen die Berechnung der Wahrscheinlichkeitsverteilung der Teststatistik und die Angabe eines -für diesen Test definierten- p-Wertes bei einseitigen und zweiseitigen Tests. Die Betrachtung der p-Werte verschiedener Nullhypothesen erlaubt die Konstruktion von Konfidenzintervallen. Der von Rubin (1974,1990) vorgestellte Ansatz zum Testen des Vorliegens individueller kausaler Effekte kann bei Modifizierung der Annahmen auch auf Nullhypothesen mit durchschnittlichen kausalen Effekten übertragen werden. Die Voraussetzung eines additiven individuellen Effektes ist dazu nicht mehr notwendig. Ohne weitere Annahmen gibt es aber keine Begrenzung der Anzahl der unter der Nullhypothese vervollständigten Werte der Responsevariablen. Zur Durchführung des Tests

ist deshalb eine Beschränkung des Wertebereiches der unbeobachteten Werte erforderlich. Eine weitere Lösung obigen Problems kann in der Anwendung eines Tests auf n-Tupel, die aus den Merkmalsträgern gebildet werden, bestehen.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 03 (see p. 55 for session)

Cheng, Tak Sum *(Hong Kong Baptist University)*
Yeung, David Wing Kay *(Hong Kong Baptist University)*

Infinite-Horizon Stochastic Control for Problems with Randomly Furcating Payoffs

In this paper, dynamic control problems with infinite horizon and stochastic dynamics and uncertain and nonautonomous future payoffs are considered. An empirically meaningful theory of optimization must incorporate uncertainty in an appropriate manner. In many dynamic control problems, the terminal time T is either very far in the future or unknown to the players. As argued by many, in this case setting may very well be the best approximation for the true game horizon.

Flemings stochastic control is the most commonly used tool for resolving of uncertainty in the state dynamics. The technique is applicable to infinite-horizon problems with autonomous future payoffs. In this paper, randomly fluctuating and non-autonomous payoffs are incorporated in the standard infinite-horizon stochastic control problem to reflect the uncertain environments over time. Important examples of this kind of problems include renewable resources extraction, environmental management, and the pricing of corporate equities. The introduction of this stochastic specification lead to a novel approach to solve dynamic problems in terms of properties and solution concepts not explored in the literature before. New and significant mathematical results are obtained, under which it becomes possible to characterize the conditions under which previously unsolvable games can be solved. An application of the technique in solving an infinite-horizon resource extraction planning problem is presented.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 03 (see p. 58 for session)

Farkas, Zoltan *(National Institute of Labour Hungary)*

On an Optimum Invariance Property of Synthesizing Decisions by using Method "Optimization with Minimal Information"

Let us assume that in a decision problem a certain number of individuals form independent quantifiable decisions (judgements) about some phenomena on the base of certain directly measurable attributes as variables with constraint of an objective function to be used for some evaluation of these decisions. Let us further assume that we want to synthesize their decisions in order to achieve some consensus among them. Some questions arise as follows:

1. What may be criteria of some consensus and how to synthesize judgements for reaching it?
2. Are there any invariance properties of such a synthesis and if any, how to find and give them?

This presentation tries to answer above questions for a well-defined class of decision problems with some type of constraints and evaluation (objective) functions. For this class of decision problems we obtain an invariance property of solution, if we use method "Optimization with Minimal Information". That means solution of such type of problems gives solution for a whole class of decision problems for reaching some consensus independently from the given instance of this problem. Presentation shows some extensions of the author's earlier results concerning this topic.

Z. Farkas (1978): A generalized application of the method "Optimization with Minimal Information" – "OMI" into some allocation problems (In: MTA SzTAKI Közlemények) 20. pp. 53–69.

Z. Farkas (1980): Solution of a modified transportation problem with penalty function by method "OMI". In Methods of Operations Research, Vol. 40, pp. 85–89.(Anton Hain V.)

Z. Farkas (1988): On some extension of quasi-arithmetic means and their connection with solution of certain decision problems. Pres. at 13. SOR, Paderborn; In the Methods of Op. Res. No. 60

Z. Farkas (1997): On the solution method "OMI" 16. Internat.Symposium on Math.Progr., Lausanne, 1997, Abstracts pp.89

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 03 (see p. 52 for session)

Kogelschatz, Hartmut *(Alfred-Weber-Institut, Universität Heidelberg)*

On the Leontief Inverse of a Beta Distributed Input Matrix

Input-output models are used to be based on a deterministic input matrix $A \geq 0$.

In this paper, the input coefficients are assumed to have a standard beta distribution, which seems to be adequate for modelling the density of the input coefficients $a_{ij} \ll 1$. A is assumed to have a dominant eigenvalue less than one which is equivalent to existence and non-negativity of the Leontief inverse $L(A) = (I - A)^{-1}$.

The distribution of the random matrix $L(A)$ is derived for any distribution of A by

$$f_L(L) = |J(I - L^{-1})|^{-1} f_A(I - L^{-1}) \quad \text{for } L - I \in R^{n^2}_{++},$$

where $|J(I - L^{-1})|^{-1} = |I - A|^{2n}$ is the reciprocal Jacobian of g with $A \mapsto L$, and g is a diffeomorphism. Upper bounds $\ll 1$ can be given for $|J|$, e.g. by Hadamard's inequality for determinants of positive definite matrices. The distribution of L in comparison to that of A is extremely dampened for $|I - A|$ approaching zero.

A multivariate standard beta distribution (Dirichlet-distribution) is assumed for each sector j since the input coefficients and the value added coefficient v_j add up to one (columnwise). Assuming that the n Dirichlet distributed random vectors are stochastically independent, the distributions of the random matrix A and L are determined. The marginal distributions of $Y_i = A_{ij_0}$ are standard beta distributions and $cov(Y_i, Y_j)$ for $i \neq j$ is very small on the average.

For a stochastic input matrix A with beta distributed input coefficients lower bounds of the Leontief inverse $L(A) := (I - A)^{-1}$ are investigated by 2×2 principal minors of A. For the approximating Leontief inverse $\tilde{L}(A)$ the exact distribution of the diagonal elements (-1) can be derived as a beta distribution of the second kind, whereas that of the off-diagonal elements will be approximated by means of a theorem of Fan.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 03 (see p. 40 for session)

Krätschmer, Volker *(Universität des Saarlandes, Saarbrücken)*

Least Squares Estimation in Linear Regression Models with Vague Concepts

The talk will be a contribution to parameter estimation in fuzzy regression models with random fuzzy sets. Here models with crisp parameters and fuzzy observations of the variables are investigated. This type of regression models may be understood as an extension of the ordinary single equation linear regression models by integrating additionally the quantitative vagueness inherited in the ideas of the involved items. So the significance of these regression models is to improve the empirical meaningfulness of the relationship between the items by a more sensitive attention to the fundamental adequacy problem of measurement. Concerning the parameter estimation the ordinary least squares method will be extended. Generalizing asymptotic properties of ordinary least squares estimators it can be shown that estimators derived from the extended least squares method are strong consistent with a piecewise normal distribution as limiting distribution.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 03 (see p. 58 for session)

Lee, Hsuan-Shih *(Dept. of Shipping and Transp. Management, National Taiwan Ocean Univ.)*

Aggregation of Comparison Matrices in AHP under Group Decision Making Environment

Tackling multi-criteria decision making problems with AHP, judgements of decision makers are represented by positive reciprocal matrices (pairwise comparison matrices) with ratio judgements representing the preference of a decision maker. In this paper, we are going to propose a new method for aggregating individual ratio judgments into a group consensus. With the aggregation we proposed, the sum of weighted squared distance among the aggregated consensus and individual opinions is minimized. Under the aggregation, the aggregation weight of a opinion is larger if it is closer to the consensus, while the aggregation weights of the extreme opinions would be lesser. An iterative procedure is proposed to reach the consensus. A mathematical proof of the soundness of the procedure is also provided.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 03 (see p. 55 for session)

Loucopoulos, Constantine *(Northeastern Illinois University, Chicago)*

A New Mathematical Programming Approach for the Minimization of Misclassification Costs

In this paper, a two-phase mathematical programming programming procedure is proposed for the minimization of misclassification costs in the three-group classification problem. The proposed mathematical programming procedure allows the assignment of distinct costs to the misclassification of an observation from one group, to each of the other two groups. In the first phase, a MIP model is used to obtain discriminant scores for each observation. In the second phase, the same MIP model is used with the additional constraint that the sample covariance of the discriminant scores obtained in the two phases is equal to zero. Thus, the second discriminant will spread the data in a different direction from the direction that the first discriminant spread the data. The discriminant scores obtained in the two phases

are then plotted and a grid of nine cells is generated. A cell is assigned to a particular group, if the misclassification cost for that cell is minimized by such group assignment. A rule is proposed for group assignment, when there is a tie in the minimum misclassification cost for a cell, as well as when there are no observations in a particular cell. The performance of the proposed two-phase procedure is compared against that of a recently published model for the minimization of misclassification costs, using a variety of data configurations and misclassification cost structures.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 03 (see p. 52 for session)

Protsenko, Artem *(Sobolev Inst. of Mathematics, Novosibirsk)*

Imitation Model of the Metal Market Functioning

The given work is a part of the investigations dedicated to development of an economic evaluation approaches to mineral deposits in the current situation in Russia. The economic evaluation is regarded as calculation of a set of coefficients defining the efficiency of a development project. These coefficients are based on the ideas of the IRR and NPV but they include the essential nonstationarity of the macroeconomic conditions in the prognostic period. To obtain these economic estimations, a simulation computer model for the development process of a mineral raw material deposit was developed in details. This model describes processes of extraction, processing of raw materials in a deposit place, refining and transportation to the markets. The expected dynamics of the demand and various kinds of the macroeconomic environment behavior are given exogenously in the model as a set of scenarios and studied their influence on the economic evaluation of the deposit. The numerical experiments revealed that the scenario components concerned with prices on the products have the most significant effect on the economic evaluation. It has caused the further detailed studying of possible approaches taking proper account of the current economic trends in the world to develop forecast methods for a raw material market situation.

The world experience shows that such factors as demand changing, using high technology, developing new major deposits and closing old ones make a strong impact on the price movement. It is these factors, which are a basis of the suggested dynamic spatial model of a world metals market. As a result, the model forecasts an arising market situation with the assumption that the fixed and exogenously given scenario of the external conditions will be realized. Some components of this scenario describe our hypotheses concerning the expected demand dynamics, technological progress, developing new deposits, macroeconomics in some countries, etc.

Friday, Sep. 5, 2003, 13:30 – 15:30, Room: NU 03 (see p. 58 for session)

Turkan, Yusuf Sait *(Department of Industrial Engineering, Istanbul Universiy)*
Erenay, Bulent *(Department of Industrial Engineering, Istanbul Universiy)*
Yumurtaci, Hacer *(Department of Industrial Engineering, Istanbul Universiy)*

A Solution Proposition For The Decision Problem Defining The New Routes of Istanbul Hydrofoils

Istanbul Hydrofoils attach importance to customer requirements and customer pleasure. Because of changeable customer requirements and factors in environment, company have to make some reforms. Istanbul Hydrofoils had been planning to change some of buses routes. A group of industrial engineers had been taking part in project on routes of Istanbul Hydrofoils. In this article we aim to expound the studies in this project. We analyzed the improved solutions and define their preferences.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 03 (see p. 40 for session)

Vogel, Silvia *(Technical University Ilmenau)*

Stochastic Optimization and Statistical Estimates

Stability theory of stochastic programming can be employed to derive statements on consistency and the asymptotic distribution of statistical estimates. We shall deal with cases where constraints have to be taken into account and/or the optimizer of the limit problem is not unique. Emphasis will be put on convergence in distribution.

4.15 Section 15: Experimental Economics, Game Theory and Auctioning

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1016 (see p. 52 for session)

Badegruber, Thomas *(Universität Graz)*

New Aspects of Learning Speed and Convergence in the Santa Fe Artificial Stock Market

The Santa Fe Artificial Stock Market (SFI ASM) is a widely known classical example of Agent-Based Computational Economics. Original publications by Brian Arthur et al. (1997) and Blake LeBaron (1999) describe time series properties and learning behavior of the model. A key finding is the emergence of two market regimes. Slow learning leads to convergence to the rational expectations equilibrium where agents make no use of technical information. When learning occurs at a higher speed, technical information, such as moving averages of share price, seems to provide useful information for agents. Faster learning, so the conclusion of the authors, leads to self-enforcing trading strategies among agents. Similar phenomena are assumed to play a role in actual financial markets.

Although several papers about the SFI ASM have been published in the meantime, the correct working of the published source code has never been under scrutiny. As a matter of fact, none of the publicly available versions is able to reproduce the published results. After finding the original version of the model and comparing it with the latest one the reasons could be revealed. Some of them are errors, in the sense that the model does not do what it is supposed to do. Others are modifications, in the sense that things which can reasonably be done in slightly different ways can have serious consequences for the results.

The findings offer new insights not only for the market itself, but also for the methodology of Agent-Based Computational Economics and Finance. Most importantly, no model should be published without the corresponding source code.

The model is extended in several ways. Faster computers allow for model runs with a far greater number of agents (250 instead of 25) and for much longer time periods (2.500.000 trading cycles instead of 250.000). Social behavior among agents, which was not part of the original model design, is added as a possible strategy of agent learning.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1016 (see p. 48 for session)

Galiano, Graziano *(University of Rome Tor Vergata)*
Augugliaro, Marco *(University of Rome Tor Vergata)*
Carotenuto, Pasquale *(ITIA CNR, Rome)*

A Cumulative Genetic Algorithm to Solve Combinatorial Auction

Given the wide popularity of auction on the Internet and the increase of electronic commerce, efficient auction design has become a subject of considerable importance for researchers. Of particular interest are multi-object auctions where the bids name bundles of goods, called combinatorial auctions (CA). The sellers aim is to allocate the goods, in order to maximize his revenue. In the general case this optimization problem is intractable; in practice it is possible to achieve this result using heuristic methods, which search approximation of the optimal allocation.

In this paper we present an algorithm, called CGA (Cumulative Genetic Algorithm) to compute the winners in a general multi-unit combinatorial auction. The algorithm encodes a potential solution of the problem on a simple chromosome-like data structure and apply recombination operator to these structures so as to preserve critical information. The method involves genetic operators and an evaluation of the feasibility for the solution value, according to the goods really in stock. We then provide encouraging experimental results from an implemented version of the algorithm.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1016 (see p. 52 for session)

Oyama, Daisuke *(Department of Economics, University of Vienna)*
Takahashi, Satoru *(Department of Economics, Harvard University)*
Hofbauer, Josef *(Department of Mathematics, University of Vienna)*

Monotone Methods for Equilibrium Selection under Perfect Foresight Dynamics

This paper studies equilibrium selection in supermodular games based on a class of perfect foresight dynamics. A normal form game is played repeatedly in a large society of rational agents. There are frictions: Opportunities to revise actions follow independent Poisson processes. Each agent forms his belief about the future evolution of action distribution in the society to take an action that maximizes his expected discounted payoff. A perfect foresight path is defined to be a feasible path of action distribution to which every agent at revision opportunity takes a best response. A Nash equilibrium is said to be absorbing if there exists no perfect foresight path escaping from a neighborhood of this equilibrium; a Nash equilibrium is said to be globally accessible if for each initial distribution, there exists a perfect foresight path converging to this equilibrium. By exploiting the monotone structure of the dynamics, a unique Nash equilibrium that is absorbing and globally accessible for any small degree of friction is identified for certain classes of supermodular games. For games with monotone potentials, the selection of the monotone potential maximizer is

obtained. Complete characterizations of absorbing equilibrium and globally accessible equilibrium are given for binary supermodular games. An example demonstrates that unanimity games may have multiple globally accessible equilibria for a small friction.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1016 (see p. 48 for session)

Reiß, J. Philipp *(Otto-von-Guericke-Universität Magdeburg)*
Schöndube, Jens Robert *(Otto-von-Guericke-Universität Magdeburg)*

On Participation and Bidding in Sequential Procurement Auctions

A key feature of procurement auctions is its sequential nature. Usually procurers differ across regions, countries, firms, and institutions and set independently from each other different auction dates implying a sequence of auctions. Although the sequential nature of procurement auctions is prevalent, most theoretical studies implicitly abstract it away by focussing on a single procurement auction in isolation. While this is appropriate in the absence of capacity-constraints, their presence render these bidding models inapplicable.

In our paper, we attempt to fill this gap in the literature by analyzing the entry and bidding behavior of capacity-constrained firms in a sequence of two procurement auctions where lowest sealed bids win. Particularly, we study the entry decision in the context of privately known completion cost rankings and analyze how firms refine their bidding strategies with opportunity costs of early bid submission. Our main findings are that the entry decision depends on relative project completion cost levels and equilibrium bidding in both auction stages deviates from the standard SIPV bidding model due to opportunity costs of bidding created by possibly employed capacity. Firms with lower completion costs for the first project auctioned off always submit bids while firms with lower completion costs for the project subsequently auctioned off only participate if their opportunity costs are not too large. Each firm entering the first auction includes its option value of the second project in its bid for the first project. Revenue equivalence between the first-price and second-price sealed-bid auction formats suggests that these results on entry and bidding don't depend on the auction design.

The model explains that firms with identical completion costs for the first project may differ in entry and bidding strategies.

In addition, experimental data is reported to assess the high predicitive power of the model.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: AW 1016 (see p. 48 for session)

Vries, Sven de *(Technical University München)*
Schummer, James *(Northwestern University, Evanston)*
Vohra, Rakesh V. *(Northwestern University, Evanston)*

On Ascending Vickrey Auctions for Heterogeneous Objects

We consider a setting in which bidders have nonadditive valuations for sets of heterogeneous, indivisible objects. We construct an ascending auction by using a primal-dual algorithm associated with a linear programming formulation of the efficient-allocation problem for this setting. The auction assigns nonanonymous prices to sets, and asks bidders which sets they demand in each round. Prices are increased by determining a "minimally undersupplied" set of bidders. We consider this concept to be the natural generalization of an "overdemanded" set of objects, introduced by Demange, Gale, and Sotomayor (1986) for the one-to-one assignment problem.

Under a substitutes condition, the auction implements the Vickrey-Clarke-Groves outcome. Furthermore, we show that this substitutes condition is a necessary condition to do so.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1016 (see p. 52 for session)

Wolff, Reiner *(University of Fribourg)*

A Characterization of Equitable Core Allocations in Cost-Sharing Games

The pre-nucleolus is a popular egalitarian solution concept for cost-sharing games. A drawback of this concept is that an associated cost allocation often cannot be calculated in polynomial time. Therefore, it would be convenient to know whether the pre-nucleolus of a particular game coincides with the outcome of a cost-allocation method which is computationally less demanding. We provide necessary and sufficient conditions for a coincidence of the pre-nucleolus (point) of a cost-sharing game and the centre of the game's imputation set (CIS vector).

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: AW 1016 (see p. 52 for session)

Yeung, David Wing Kay *(Hong Kong Baptist University)*

Endogenous-Horizon Randomly Furcating Differential Games

In many game situations, horizon endogeniety is common. Important cases include the extraction of exhaustible resource from a common pool, competition for market shares under given demand, sharing of CPU time by competing computer users, allocations under fixed funding, claims on frontier land by homesteaders, and economic development under a global environmental constraint. These situations are essentially differential games, in which playing ends when a subset of state variables reaches certain target levels at terminal time. A special feature of such games is that the horizon is not fixed at the outset: Instead, it is determined endogenously by the actions of the players.

This paper widens the scope of endogenous-horizon differential games by introducing uncertainty into the model. In particular, random shocks are allowed to appear in the players future payoffs. Since these payoffs are uncertain, the term randomly furcating is introduced to emphasize that a useful way to analyze such situations is to assume that payoffs change at any instant of time according to known probability distributions defined in terms of multiple-branching stochastic processes.

A particularly fruitful way of approaching complicated games with endogenous horizons follows. The application of differential game theory is widened to problems where future environments are not known with certainty. For the first time, theorems characterizing feedback Nash equilibrium solutions become possible for this kind of game problems. In addition, an illustration is provided.

4.16 Section 16: Managerial Accounting

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 06 (see p. 48 for session)

Asseburg, Holger *(Universität Hannover)*
Hofmann, Christian *(Universität Hannover)*

Relative Performancebewertung auf Oligopolmärkten

Vergütungssysteme auf Basis einer relativen Performancebewertung können den trade-off zwischen Risiko und Anreizen reduzieren, indem sie systematisches Risiko aus der Managementvergütung herausfiltern: zum einen lässt sich die zu zahlende Risikoprämie verringern; zum anderen erleichtert eine verbesserte Identifikation der Managementleistung die Anreizgestaltung. Die Verknüpfung der Managementvergütung mit der Performance direkter Konkurrenzunternehmen beeinflusst ferner das strategische Wettbewerbsverhalten der Manager.

Der Beitrag untersucht die Wirkungsweise und optimale Gestaltung linearer Anreizverträge auf Basis relativer Performancebewertung für unterschiedliche Wettbewerbsbedingungen und zeigt die Interdependenzen der Einsatzzwecke Anreizsetzung, Risikoteilung und Wettbe-werbssteuerung auf. Für den trade-off zwischen den Einsatzzwecken werden Einschränkungen der optimalen Vertragsparameter abgeleitet, die Implikationen für zukünftige empirische Untersuchungen liefern. Es zeigt sich, dass die optimale Ausgestaltung der relativen Perfor-mancebewertung zentral von den vorliegenden Wettbewerbsbedingungen und dem Grad der Risikoaversion der Manager abhängt.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 06 (see p. 55 for session)

Bauer, Ralf *(University of Mannheim)*
Schneeweiss, Christoph *(University of Mannheim)*

On the Decision-Oriented Assignment of Common Cost

The paper investigates the problem of allocating common cost as a problem of Distributed Decision Making (DDM). Focusing on decision-oriented costs we are assigning costs to single products such that the sum of common costs and the direct single product costs be minimum. To achieve the assignment we are following a two phase procedure. First we calculate common cost for an aggregate resource optimization problem and construct an adjoint operational multi-product model with the optimized resource as a production constraint. In a second step we then separate via a cost allocation device this multi-product model. This is accomplished in employing a modified Dantzig/Wolfe algorithm, accounting for the MIP property of the involved models. The paper illustrates the results with a numerical analysis. In particular it is shown that classical cost allocation procedures, like cost allocation by fairness for equity, by ability to bear, or by benefits received, are inferior as compared with the decision-oriented cost assignment developed in this paper.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 06 (see p. 55 for session)

Behrens, Sven *(Fakultät für Wirtschaftswissenschaft, Ruhr-Universität Bochum)*

Zur Manipulierbarkeit von Ergebnissen der Data Envelopment Analysis

Die Data Envelopment Analysis (DEA) ist ein Instrument zur Effizienzanalyse, das vorwiegend für den Betriebsvergleich im Rahmen des Benchmarking eingesetzt wird. DEA eignet sich auch und gerade zur Effizienzmessung in Dienstleistungsunternehmen und in Non-Profit-Organisationen und ist auch in Deutschland auf ein positives Echo gestoßen. In diesem Beitrag wird der Fokus auf immanente Grenzen der DEA gelegt, indem aufgezeigt wird, wie die Ergebnisse einer DEA bei der Durchführung manipuliert werden können. Im einzelnen hängen die Ergebnisse einer DEA vom Modellumfang - ausgedrückt in Größe und Zusammensetzung der Alternativenmenge -, von der Modellkomplexität - ausgedrückt durch die Anzahl und Aggregation der verwendeten input- und Outputgrößen - und von der zugrunde gelegten Technologieannahme ab. Die Wirkung dieser drei Einflüsse und das Ausmaß dieser Auswirkungen wird anhand der klassischen DEA-Anwendung auf das Programm Follow Through zur Evaluation von Schulen (Charnes / Cooper / Rhodes, 1981) demonstriert. Die Ergebnisse dieses Beispiels lassen die Frage nach der Stabilität und Robustheit der DEA in einem neuen Licht erscheinen.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 06 (see p. 40 for session)

Daugart, Jan *(Universität Hannover)*
Hofmann, Christian *(Universität Hannover)*

Unternehmenssteuerung mit undifferenzierten Anreizsystemen

Das Controlling in Unternehmungen sieht sich zahlreichen Restriktionen ausgesetzt, welche eine differenzierte Steuerung von Entscheidungen unterschiedlicher Unternehmensmitglieder nicht zulassen. Diese Restriktionen können zum einen auf externen Rahmenbedingungen beruhen, zum anderen können sie aber auch selbst auferlegt sein. Letzteres ist z.B. gegeben, wenn die Unternehmenssteuerung aufgrund strategischer Überlegungen oder durch Merkmale der Organisation beschränkt werden. Eine durchgehend einer speziellen Situation angepasste Unternehmenssteuerung ist daher nicht immer möglich oder zu aufwendig. Folglich besteht ein trade-off zwischen den Wirkungen differenzierter sowie eingeschränkter Steuerung, d.h. zwischen den Kosten der Differenzierung und den gezielten Anreizwirkungen differenzierter Verträge.

Der Beitrag untersucht im Rahmen eines Mehr-Agenten-Modells, wie sich zwei spezielle Restriktionen auf die Unternehmenssteuerung auswirken. Zum einen wird analysiert, inwiefern ein restriktives Anreizsystem mit undifferenzierten Verträgen für unterschiedliche Agenten Einfluss auf den Unternehmenserfolg hat. Zum anderen wird der Einfluss eines eingeschränkten Informationssystems in Form undifferenzierter Performancemaße untersucht. Es werden Bedingungen für die Äquivalenz einer undifferenzierten und einer differenzierten Steuerung herausgearbeitet und Gestaltungsempfehlungen für eine Performancemessung und Anreizgestaltung abgeleitet.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 06 (see p. 40 for session)

Dierkes, Stefan *(Universität Leipzig)*

Die Konzeption operativer Planungsrechnungen aus kapitalmarkttheoretischer Sicht

Im Rahmen einer wertorientierten Unternehmensführung wird dem Risiko einer künftigen Zahlung durch die Verwendung eines dem Risiko angepassten Kapitalkostensatzes Rechnung getragen, zu dessen Ermittlung zumeist auf den Kapitalmarkt und insbesondere auf das Capital Asset Pricing Model zurückgegriffen wird.

In diesem Beitrag wird analysiert, inwieweit operative Absatzpreis- und Absatzmengenentscheidungen Auswirkungen auf die risikoangepassten Kapitalkostensätze zur Bewertung künftiger Zahlungen haben. Die Untersuchung wird für monopolistische und oligopolistische Preis-Absatz-Funktionen im Falle des Preis- und des Mengenwettbewerbs durchgeführt. Hierbei werden jeweils mit der (additiven und multiplikativen) unspezifizierten Berücksichtigung des Risikos in der Gewinnfunktion sowie der spezifizierten Berücksichtigung des Risikos in der Preis-Absatz-Funktion unterschiedliche Fälle der Einbeziehung des Risikos behandelt. Darüber hinaus wird untersucht, welche Auswirkungen sich aus der zusätzlichen Berücksichtigung einer absatzmengenabhängigen, zeitlich vorgelagerten Zahlung ergeben. Auf der Grundlage der erzielten Ergebnisse wird analysiert, welche Folgen sich hieraus für die Konzeption operativer Planungsrechnungen aus kapitalmarkttheoretischer Sicht ergeben. Dabei zeigt sich, dass die aus kapitalmarktorientierter Sicht optimalen Produkti-ons- und Absatzmengen teilweise nur durch den expliziten Ansatz von Wagnis- bzw. Risikokosten bestimmt werden können, wodurch das von den Eignern zu tragende systematische Geschäftsrisiko explizit Eingang in die Kostenrechnung findet. Insgesamt liefert der Beitrag damit eine theoretische Begründung für den Ansatz von Wagnis- bzw. Risikokosten in operativen Planungsrechnungen.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 06 (see p. 52 for session)

Friedl, Gunther *(Ludwig-Maximilians-Universität München)*

Incentive Properties of Residual Income when there is an Option to Wait

Performance measures based on residual income are getting increasingly popular. The academic literature has shown that residual income has some important incentive properties when investment decisions are based on the net present value rule. This analysis focuses on the case when investment decisions can be postponed. Then the simple net present value rule has to be extended by considering an option value. The analysis shows that some important incentive properties of residual income still hold when there is an option to wait, but only when the residual income measure is correctly adjusted. The paper also provides an incentive-based explanation of why the capital charge rate within firms is often significantly higher than the firms cost of capital.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 06 (see p. 44 for session)

Hofmann, Christian *(Universität Hannover)*

Gestaltung von Erfolgsrechnungen zur Steuerung langfristiger Projekte

In zahlreichen Branchen kommt langfristigen Projekten wie einer mehrjährigen Auftragsfertigung, der Forschung und Entwicklung oder der Neueinführung von Produkten am Markt eine große Bedeutung zu. Für das Controlling besteht eine zentrale Aufgabe darin, Anreizverträge sowie mehrperiodige Erfolgsrechnungen zu entwickeln, damit die Manager solche Handlungen wählen, die den Unternehmenswert steigern. Aufgrund des langfristigen Charakters von Projekten ist als wichtiger Einflussfaktor zu beachten, dass rationale Entscheidungsträger im Zeitablauf einvernehmlich die geschlossenen Verträge an neue Informationen anpassen können (sequentielle Rationalität).

Der Beitrag vergleicht die Steuerung von Projektleitern über eine Projekterfolgsrechnung sowie eine Periodenerfolgsrechnung. Während bei ersterer der Projekterfolg mit dem Zahlungseingang zum Projektende realisiert wird, nimmt die zweite Rechnung eine "periodengerechte Gewinnermittlung" vor. Dazu sind Informationen eines Projektzwischenberichts erforderlich. Die Modellergebnisse zeigen Bedingungen auf, bei denen eine der beiden Rechnungen dominiert. Die Dominanz ist insbesondere von dem Informationsgehalt des Zwischenberichts abhängig. Letztlich zeigt sich, dass für die betrachtete Problemstellung ein mehr an Informationen nicht durchweg zu einem höheren Unternehmenserfolg führt.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 06 (see p. 48 for session)

Korn, Evelyn *(Eberhard Karls Universität Tübingen)*
Lengsfeld, Stephan *(Eberhard Karls Universität Tübingen)*

Zur Durchsetzung des Arm's Length Grundsatzes – Eine Win-Win Situation?

Zahlreiche – insbesondere europäische – Länder gehen davon aus, dass multinationale Konzerne ihre Verrechnungspreise zur Verschiebung von Gewinnen in Länder mit niedrigen Steuersätzen nutzen. Um einen solchen Verlust von Steueraufkommen zu vermeiden, werden zunehmend Regelungen eingeführt, die die Angemessenheit der Verrechnungspreise multinationaler Konzerne sicherstellen sollen. Zu diesen Regelungen gehört eine Ausweitung der Dokumentationspflicht von Verrechnungspreisen sowie eine Verschärfung der entsprechenden Kontrollen. Die vorliegende Arbeit zeigt mit Hilfe eines spieltheoretischen Modells, dass die Unternehmen drei Effekte gegeneinander abwägen: Positionierung im Wettbewerb, Minimierung der Steuerlast und Vermeidung von Strafzahlungen. Dort, wo schärfere Kontrollen überhaupt zu verändertem Verhalten führen, können sie im Interesse von Staat und Unternehmen sein.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 06 (see p. 40 for session)

Krapp, Michael *(University of Augsburg)*

Zur Manipulationsresistenz kollektiver Entscheidungsregeln

Kollektive Entscheidungsregeln sind Mechanismen, die jedem Profil von Präferenzordnungen der Mitglieder eines Gremiums eine der zur Auswahl stehenden Alternativen als Gremienentscheidung zuordnen. Obwohl die Anzahl kombinatorisch möglicher kollektiver Entscheidungsregeln exponentiell mit der Alternativenzahl und der Gremiengröße anwächst, lässt sich keine kollektive Entscheidungsregel finden, die frei von Schwächen ist: Dem Unmöglichkeitstheorem von Gibbard (1973) und Satterthwaite (1975) zufolge kann jede nichtdiktatorische kollektive Entscheidungsregel mit universellem Definitionsbereich durch strategisches Abstimmen manipuliert werden. Der von Gibbard und Satterthwaite zu Grunde gelegte Manipulationsbegriff unterstellt jedoch unter anderem, dass a) Manipulationen kostenlos möglich sind und dass b) stets nur ein Gremienmitglied strategisch abstimmt. Beide Prämissen erweisen sich indes als realitätsfern. Welche Implikationen sich aus ihrer Relaxierung ergeben, wird im Rahmen eines Agencymodells untersucht. Es zeigt sich, dass das Manipulationsphänomen in diesem Kontext differenzierter beurteilt werden

muss: Unter Umständen sind nun theoretisch (im Sinne von Gibbard und Satterthwaite) manipulierbare kollektive Entscheidungsregeln de facto manipulationsresistent beziehungsweise gegenüber strategischem Abstimmen immunisierbar. Die zur Immunisierung geeigneten organisatorischen Gestaltungsmaßnahmen werden durch Übertragung einschlägiger spieltheoretischer Ergebnisse identifiziert.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 06 (see p. 52 for session)

Luhmer, Alfred *(Otto-von-Guericke-Universität Magdeburg)*

Investing in the Agent's Productivity

A principal-agent model of the LEN type is studied in which the agent's productivity can be enhanced at a cost.

Two situations are compared: in the first one gross output of the agency is assumed contractible as is the productivity-enhancing investment. In the second one the agent decides on how to equip himself while the principal sees only the outcome net of the productivity-enhancing cost.

The first best level of productivity is compared to the second best under the two scenarios and a sensitivity analysis is carried out in order to find out how the agent's risk aversion and effort aversion influence his working conditions.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 06 (see p. 44 for session)

Lukas, Christian *(Otto-von-Guericke Universität Magdeburg)*

Executive Pay: Prior Successes and Future Incentives

Executive compensation has become a field of intense (agency-)theoretical and empirical research. A theoretically rather unexplored area is the absolute level of pay and what accounts for differences in absolute pay. In this paper a two-period agency model is developed to determine a pay structure that provides incentives for managerial effort and uses informative signals about the agent's ability. The resulting pay structure does not always award the most successful agent with the highest pay. A more risky distribution of the agent's ability generates a less costly information system. Model extensions with regard to manipulable outcomes and multiple periods are also analyzed.

Friday, Sep. 5, 2003, 08:30 – 10:00, Room: NU 06 (see p. 55 for session)

Missler-Behr, Magdalena *(Wirtschaftswissenschaftliches Zentrum, Universität Basel)*

Ein Stichprobenmodell zur Retourenkontrolle

Händler beliefern eine zentrale Verteilstelle, die wiederum die Produkte an Verkaufsstellen ganz unterschiedlicher Größenordnungen weitergibt. Die nicht verkaufte Ware wird komplett an die zentrale Verteilstelle zurückgeschickt. Bis dato fordern die Händler von der Verteilstelle eine hundertprozentige Kontrolle der Retourangaben und der tatsächlichen Retouren der Verkaufsstellen, um ihren Schaden bei Falschangaben genau beziffern zu können.

Es galt ein Stichprobenmodell zu entwickeln, das aus Sicht der zentralen Verteilstelle mehreren unterschiedlichen Zielsetzungen gerecht werden soll.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 06 (see p. 52 for session)

Pfeiffer, Thomas *(Accounting and Control, Vienna University)*
Schneider, Georg *(Accounting and Control, Vienna University)*

Integrated Incentive Plans and Capital Budgeting

Budgeting and transfer pricing are the two most common instruments used in practice to control and co-ordinate decentralized intra-firm resource allocation processes. In our model we expand a standard capital budgeting model of Amershi and Cheng (1990) by introducing a second profitability parameter of the project, which is unknown to both parties. The time sequence is as follows: First, at point of time central management has to budget capital from the outside market, the first productivity parameter is private information of the divisional manager. Then after central management has budget the capital, the second profitability parameter get realized and the manager has to exerts his level of effort. In this setting, we analyze stand-alone incentive plans based on budgets or transfer prices and integrated incentive plans based on budgets and transfer prices.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 06 (see p. 48 for session)

Pirchegger, Barbara *(Otto-von-Guericke Universität Magdeburg)*
Riegler, Christian *(Wirtschaftsuniversität Wien)*

Choice of Managerial Performance Measures and Their Effect on Incentives for Takeovers

Shareholder Value Management and management compensation have been discussed frequently over the past decade. Many companies picked up ideas from this discussion and implemented compensation contracts supposed to align managers' and shareholders' interests. These contracts link managerial payment to different performance measures.

One opportunity to create value for a company's owners is to take over other firms. This might be especially valuable in the situation of down markets faced right now. Given this environment, we analyze incentives created by frequently used performance measures in takeover situations. An appropriate performance measure needs to motivate a takeover whenever it is favorable from the owners' perspective and to disencourage takeovers otherwise.

Most of the literature on mergers and acquisitions models takeovers within a setting of oligopoly markets and Cournot-competition. Consequences of takeovers on owners' welfare are analyzed either in a market of owner managed firms or in a market in which companies are run by managers, which allows for strategic effects. It has been shown that contracting and delegation benefits the owners. However, profit and sales have served as the unanimously used performance measures in management compensation contracts in this literature even though especially sales figures appear to be rarely observed empirically. Therefore this paper introduces alternatively indexed profits or, equivalently, indexed market values as performance measure. It turns out that while profit and sales always induce correct incentives for takeovers, alternative performance measures do not. Moreover, we find that the effectiveness of the performance measures captured crucially depends on the market structure given. If the market structure is dominated by owner managed firms, profit and sales tend to perform very well. In market structures characterized by a high percentage of firms run by managers indexed profits appear to be superior.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 06 (see p. 44 for session)

Schöndube, Jens Robert *(Otto-von-Guericke Universität Magdeburg)*

Performancemessung und Informationsgehalt in einer Agency-Beziehung mit beschränkter Selbstbindungskraft

In der Praxis sind langfristig bindende Verträge oft wenig glaubhaft, vor allem dann, wenn sie auf der Basis in der Zukunft zu erhebender, aber verrauschter Erfolgsmaße die Kompensation unbeobachtbarer früherer Leistungen eines Agenten versprechen. Allzu leicht lässt sich mit dem Wegfall der Geschäftsgrundlage argumentieren, um Nachverhandlungen durchzusetzen, die den Agenten um den Lohn vergangener Leistungen bringen. Der Agent sieht das voraus und ist daher zu solchen nicht im ex ante effizienten Ausmaß bereit. Aufbauend auf den existierenden Ergebnissen der informationsökonomischen Rechnungslegungstheorie wird zunächst das Informativeness-Prinzip genutzt, um Bedingungen zu charakterisieren, unter denen ein System von Performancemaßen zu einem Effizienzverlust durch Nachverhandlungen führt. Die Analyse stellt dabei konsequent auf mehrdimensionale Aktionen und Performancemaße ab. Anschließend wird untersucht, wie sich unterschiedliche Informationssysteme auf die aus der Nachverhandlungsmöglichkeit resultierenden Effizienzeinbußen auswirken. Im Vordergrund des Interesses steht dabei der Vergleich zwischen Cash Flows und kaufmännischen Periodenerfolgen als Informationssysteme zur Steuerung des Agency-Konflikts. Zudem wird gezeigt, dass es unter Berücksichtigung von Nachverhandlungen optimal sein kann, dem Manager die Durchführung bilanzpolitischer Maßnahmen zu erlauben, die zwar die Bemessungsgrundlagen seiner Vergütung, nicht aber das Ziel des Prinzipals beeinflussen. Indem die Erlaubnis bilanzpolitischer Maßnahmen dazu führt, dass das ex post Risiko-Anreiz-Problem verschärft wird, wirkt sie wie eine implizite Selbstbindung des Prinzipals im Nachverhandlungszeitpunkt nicht zu starke Anreize zu induzieren. Damit wird ein Baustein zu einem ökonomischen Verständnis der Tatsache geliefert, dass manipulierbare kaufmännische Erfolgsrechnungen in der Praxis immer noch weithin als Bemessungsgrundlagen für Managementanreizsysteme Verwendung finden.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 06 (see p. 40 for session)

Stephan, Jörg *(Sem. für Allg. Betriebswirtschaftslehre und Controlling, Universität zu Köln)*
Weiß, Matthias *(Sem. für Allg. Betriebswirtschaftslehre und Controlling, Universität zu Köln)*
Homburg, Carsten *(Sem. für Allg. Betriebswirtschaftslehre und Controlling, Universität zu Köln)*

Unternehmensbewertung bei atmender Verschuldung und Insolvenzrisiko

In der Literatur wird zur Unternehmensbewertung anhand der Discounted Cash Flow-Verfahren regelmäßig von einem Insolvenzrisiko abstrahiert oder die damit verbundene Problematik nicht thematisiert. Die Vernachlässigung des Insolvenzrisikos lässt sich aber allenfalls dann rechtfertigen, wenn Unternehmen eine exzellente Kreditwürdigkeit besitzen. Es weisen jedoch weltweit zur Zeit lediglich elf Unternehmen ein Standard & Poor's AAA-Rating, also die bestmögliche Kreditwürdigkeit, auf. Den Kern dieses Beitrags bildet deswegen die Erweiterung der Adjusted Present Value-Methode bei atmender, das heißt unternehmenswertabhängiger Finanzierung auf den Fall eines Insolvenzrisikos. Unternehmenswertabhängige bzw. atmende Finanzierung liegt vor, wenn die zukünftigen Marktwerte des Fremdkapitals in einem vorgegebenen Verhältnis zum gesamten Unternehmenswert (Vorgabe einer Zielkapitalstruktur) stehen. Zur

Einbeziehung des Insolvenzrisikos in die Unternehmensbewertung müssen zum einen dessen Auswirkungen auf die Tax Shields, die zu Grunde liegenden Kapitalkostensätze und den daraus resultierenden Unternehmenswert untersucht werden. Die APV-Methode eignet sich dabei in besonderer Weise zur Analyse des Insolvenzrisikos bei der Unternehmensbewertung, weil sie die Einflüsse der Investitions- und Finanzierungsentscheidungen auf den Unternehmenswert isoliert ausweist. Unter Verwendung eines das Insolvenzrisiko berücksichtigenden gewichteten Gesamtkapitalkostensatzes (WACC) ist zum anderen eine Verbindung zwischen dem Eigenkapitalkostensatz des unverschuldeten und des verschuldeten Unternehmens herzustellen. Es zeigt sich, dass die Vernachlässigung eines Insolvenzrisikos zu erheblichen Fehlbewertungen führen kann, die sich durch die modifizierte Vorgehensweise vermeiden lässt.

4.17 Section 17: Web Technology, Knowledge Management and Decision Support Systems

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 02 (see p. 52 for session)

Bartels, Patrick *(Institut für Wirtschaftsinformatik, Universität Hannover)*
Breitner, Michael H. *(Institut für Wirtschaftsinformatik, Universität Hannover)*

Financial Market Web Mining with the Software Agent PISA

The Internet is used in everyday life and became "sine qua non" in modern business. The more information is published in the Internet the more it becomes important to use the information efficiently. Software agents and web technology help to reduce work and information overload. Here, we present a platform independent software agent called PISA (Partially Intelligent Software Agent). The agent's primary instruction is to extract user specified information from the Internet. Websites are visited frequently and the extracted data are stored in either databases or plain text files. The agent's architecture, especially the extraction process, is described. There are several potential areas of application, e.g. price comparison services automatically extract product prices from several vendor's websites. Knowledge management systems and decision support systems require specific data. PISA automatically observes specified websites and downloads the wanted information if a specified event occurs. Current research on decision support systems concentrates on using artificial neural networks for decision-making. These have eminently strict requirements regarding input data quality. PISA is even capable to fulfill these constraints. PISA supports several international standards. Even websites in Asian languages can be processed. Information is extracted in intervals over a specified period to generate time series in user defined density. To avoid data gaps information is extracted redundantly. Here, we concentrate on currency exchange rates, stock quotes and derivative prices. Such time series are created cost free, an important advantage to commercial data suppliers. Another advantage is that the Internet offers information, which is not provided by any commercial provider. By merging related information pieces from several webpages their aggregated value can be increased. For further information, see http://iwi.uni-hannover.de/pisa.html.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 02 (see p. 48 for session)

Ding, Xiaosong *(Department of Information Technology and Media, Mid-Sweden University)*
Danielson, Mats *(Department of Informatics/ESI, Örebro University)*
Ekenberg, Love *(Department of Computer and Systems Sciences, Stockholm University and KTH)*

Non-Linear Programming Solvers for Decision Analysis Support Systems

The main theme is to investigate performances of existing general-purpose non-linear programming (NLP) and linear programming (LP) solvers particularly for decision analytical components in decision support systems (DSS). DELTA has been developed over a number of years for solving decision problems when vague and numerically imprecise information prevails. However, it gives rise to particular bilinear programming (BLP) issues that are time-consuming to solve. This paper presents a set of benchmark tests for standard combined LP/NLP solvers for solving BLP problems.

The first section presents the background. Much effort is devoted to introduce the novel evaluation framework, DELTA, and gives out the difficulties DELTA incurs from the computational viewpoint. Thereafter, the second section is concerned with the related optimization issues. In addition to transforming the objective function to the standard quadratic programming (QP) form and analyzing its property of definiteness, interesting QP literatures are also investigated. After pointing out the main challenge confronting us, the third section explains the design of programs and experiments in every detail. By applying the rapid standard combined LP/NLP solvers to computer-simulated real-life decision situations using the DELTA method, the BLP optimization issue are attacked from the number of constraints, various mixing strategies of three types of constraints via observing outcomes with respect to the execution time. The purpose is to figure out various impacts to our BLP problem. With two existing LP based optimization algorithms, we also carry out the comparison between LP and standard BLP algorithms to identify how large the gap is between them. Finally, the main conclusion indicates that modern NLP solvers stay far from enough to meet the real-time requirement of an interactive DSS. Consequently, we definitely need a fast algorithm to fill this demand and propose some possible approaches.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 02 (see p. 44 for session)

Goguadze, George *(Universität des Saarlandes, Saarbrücken)*
Melis, Erica *(Universität des Saarlandes, Saarbrücken)*
Izhutkin, Victor *(Mari State University, Yoshkar-Ola)*
Izulanov, Yury *(Mari State University, Yoshkar-Ola)*

Interactively Learning Operations Research Methods with ActiveMath

ActiveMath is a web-based user-adaptive learning environment that dynamically generates interactive course material that is adapted to the learner's needs. For each student, the appropriate elements of the content can be retrieved from a knowledge base. For instance,exercises with an appropriate difficulty and examples of an appropriate type. We have developed learning material about methods for linear, nonlinear, and dynamic programming (in Russian and English).

The potential of ActiveMath employed for education in operations research includes the personalization of the generated material and the generic integration of interactive elements: course elements can be chosen according to their difficulty etc. Prerequisite knowledge is also presented. Moreover, all these elements are combined with interactive visualization. Currently, the (interactive) elements are. 1. Worked-out Examples We have developed worked-out solutions for all typical types of examples. Students can consider all admissible solution alternatives. These solutions are given step by step and with methodological support including explanations and the mathematical formulae. The solutions include the numeric results as well as their explanations. Some of those examples comprise a comparison of different methods. Metadata in ActiveMath's representation of the examples encode recommendations on how to use each example.

2. Interactive Personalized Exercises with Feedback Exercises that train the usage of procedures/methods. Our interactive exercises include a direct feedback for scaffolding the student's problem solving.

Benefits and observations: the visualization helps students a great deal to understand the essence and conditions of methods much better than in traditional teaching. Exercises can be solved faster than in a traditional setting.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 02 (see p. 40 for session)

Huang, Guanwei *(University of Paderborn)*
Nastansky, Ludwig *(University of Paderborn)*

K-Pool: Concepts for Interfacing Knowledge Management and Decision Support based on Contextual Collaboration and Web Technology

Operations Research (OR) deals with a multiplicity of approaches embedding algorithmic, mathematical, and automated computational reasoning as core concept in knowledge-based application frameworks suited for supporting decision making processes (A-side). But, quite often there is a principal disproportion between the *hard-core* A-side on the one hand with all their complexity in functional approach, mathematics, algorithmic precision, or granularity of its supporting data set, and the *process enabling and decision enacting* part on the other hand bringing the computed results to life in the real world of an organizational framework (P-side). The challenges in bridging this principal incongruity between computerized results at the end of an automated algorithmic chain on the A-side and their practical enacting by people and their management capabilities essentially defining the quality on the P-side of the organization seem all the more growing.

This paper is precisely to make a contribution to the bridging domain (I-domain) between the A-side and the P-side in an organization by presenting our *k-Pool* model. K-Pool is a fully featured system environment which is to be regarded as a specific incarnation of a complex and versatile object delivering core services in the I-domain. Core features of k-Pool are to connect the A-side and P-side in an organizational environment using essential concepts in the area spanned by Web Technologies, Knowledge Management, Decision Support Systems.

In brief, this paper will focus on the k-Pool's interface positioning between A-side and P-side, the k-object container and meta-data model, the open taxonomy and view-access model, the k-Glossary and k-Taxonomy subsystems as dynamic taxonomy maintenance environment, the decision support and knowledge management functionalities, the access continuum spanning intranet, extranet and internet functions etc.

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 02 (see p. 44 for session)

Prümer, Birgit *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*
Rödder, Wilhelm *(Lehrstuhl für BWL, insb. OR, Fernuniversität Hagen)*

Eine induktive Lernstrategie zur Verarbeitung sicherer Regeln

Der Aufbau einer Wissensbasis in einer probabilistischen Expertensystemshell für unternehmerische Entscheidungsprobleme lässt sich in zwei Phasen einteilen: Die Modellierung der Sachzusammenhänge mittels meist konditionierter Ausdrücke und die Angabe von Wahrscheinlichkeiten zu diesen Konditionalen. Liegen Daten in Form von sogenannten Beobachtungsvektoren vor, so sind zwei Formen möglich, die Konditionale zu schätzen:

1. Die Konditionale sind von einem Experten vorgegeben und die Wahrscheinlichkeiten werden frequentistisch aus dem Datenmaterial geschätzt (vgl. [SPIRIT02]).
2. Man bedient sich einer vorteilhafteren Vorgehensweise durch die Anwendung eines maschinellen Lernverfahrens, um damit auch die Regeln vorzugeben.

Die Nützlichkeit dieser zweiten Alternative liegt eben in der Vorstrukturierung der Regeln, die durch die spezielle Form des maschinellen Lernens erzielt wird. So wird das hinsichtlich des Ergebnisses redundante Wissen nicht weiter berücksichtigt, sondern nur die einflussnehmenden Informationen induktiv verarbeitet. Dadurch wird die vorhandene Unsicherheit in der Wissensbasis gesenkt, wie der Beitrag zeigt.

Anhand eines ökonomischen Beispiels aus dem Bereich des Marketing/ Konsumenten-Verhaltens unter Anwendung des bekannten Top-Down Induction of Decision Trees (TDIDT)- Algorithmus ID3 [Mit97] und der probabilistischen Expertensystemshell SPIRIT (vgl. [Roe00], [Roe03]) wird dieses Modell praktisch umgesetzt.

[Mit97] Mitchell, T.: Machine Learning. WBC/McGraw-Hill, Boston, Massachusetts, 1997

[Roe00] Rödder, W.: Conditional Logic and the Principle of Entropy, Artificial Intelligence, 117 (2000) 83-106.

[Roe03] Rödder, W.: On the Measurability of Knowledge Acquisition and Query Processing, International Journal of Approximate Reasoning, 33/2 (2003) 203-218.

[SPIRIT02] SPIRIT-Version 3.1, `http://www.xspirit.de`, (2002)

Wednesday, Sep. 3, 2003, 16:45 – 18:45, Room: NU 02 (see p. 44 for session)

Reiners, Torsten *(Abt. ABWL, Wirtschaftsinf. u. Inf.management, TU Braunschweig)*
Reiß, Dirk *(Abt. ABWL, Wirtschaftsinf. u. Inf.management, TU Braunschweig)*
Sassen, Imke *(Lehrstuhl für Betriebswirtschaftslehre: Management Science, Universität Magdeburg)*
Voß, Stefan *(Abt. ABWL, Wirtschaftsinf. u. Inf.management, TU Braunschweig)*

Die adaptive virtuelle Lernumgebung SMARTFRAME

Durch den Einsatz von virtuellen Lernumgebungen können Universitäten die Qualität ihres Lehrangebotes verbessern und ihre Attraktivität für Studierende entscheidend steigern. Aktuelle universitäre Entwicklungen verfolgen jedoch i.d.R. zu schlicht gestaltete Ansätze, um eine Zielerreichung im Sinne einer spürbaren Qualitätsverbesserung des Lehrangebotes tatsächlich zu erreichen. Werden die Lernmaterialien einfach durch statische HTML-Seiten präsentiert und ohne eine mediendidaktische und mediengerechte Aufbereitung angeboten, stellt sich die Frage nach einem echten Vorteil, der durch die Verwendung des digitalen Mediums erreicht werden kann. Eine Online-Präsenz, die insbesondere auch zum Selbststudium geeignet sein will, sollte weitergehende innovative Ansätze verfolgen, um einen echten Mehrwert der elektronischen Lernmaterialien für die Lernenden zu erreichen, indem medienspezifische Möglichkeiten ausgeschöpft werden. In diesem Sinne werden bereits interaktive Applets eingesetzt, die jedoch größtenteils weitergehende didaktische Konzepte wie z.B. ein adaptives Feedback nicht integrieren.

In diesem Beitrag präsentieren wir einen Überblick unseres sowohl mediendidaktischen als auch technik-orientierten Ansatzes, der als wesentliche Zielsetzung die Steigerung des ganzheitlichen Lernerlebnisses verfolgt. So findet beim Abruf der Inhalte eine dynamische d.h. lernerspezifische Adaptivität in Bezug auf eine favorisierte Zusammensetzung und Darstellung der Lernmaterialien statt. Die technische Basis unseres mediendidaktischen Konzeptes der lernerspezifischen Adaptivität sind in XML kodierte Lernobjekte. Dies ermöglicht eine ganzheitliche Adaption, die über die bereits übliche Interaktivität einzelner Module und benutzerspezifische Eingangskonfigurationen wesentlich hinausgeht. Anhand der Implementierung der Lernumgebung und der Demonstration eines virtuellen Kurses "Simulation" soll unsere mediendidaktische Konzeption sowie technische Umsetzung verdeutlicht werden.

Thursday, Sep. 4, 2003, 08:30 – 10:00, Room: NU 02 (see p. 48 for session)

Scheubrein, Ralph *(Universität Hohenheim)*

Strukturierung von Wissensdatenbanken mit Hilfe der Metapher „Lernziel“

Bei umfangreichen Wissensdatenbanken besteht grundsätzlich die Frage, wie der Benutzer den von ihm gesuchten Content gezielt abfragen kann. Einerseits existieren Ansätze zur benutzerdefinierten Abfrage des Content (z.B. über Stichworte, Neuigkeit der Content, Häufigkeit der Nachfrage des Content, Reihenfolge der Nachfrage). Problematisch hierbei kann sein, dass die Abfrageergebnisse inhaltlich sehr divergieren. Andererseits besteht die Möglichkeit, einer vorgegebenen Gliederung des Content aufgrund einer domänenspezifischen Ontologie (z.B. Schlagworte und Synonyme in baumförmigen oder allgemeinen Netzwerken). Problematisch hierbei kann die Navigation des Benutzers in den Ergebnissen sein. Interpretiert man eine Abfrage von Content als Lernbedürfnis eines Benutzers, so liegt der Gedanke nahe, eine Strukturierung des Content anhand von Lernzielen vorzunehmen. Im Vortrag wird zur Strukturierung des Content einer zweidimensionalen Klassifizierung von Lernzielen entlang einer Prozess- und einer Wissensdimension vorgeschlagen. Die Lernziele sind für Content aus der Wissensdomäne OR/MS konkretisiert. Die Anwendung dieser

Klassifizierung wird illustriert durch die exemplarische Strukturierung von Web-Angeboten, die für die Lehre des OR/MS relevant sein können.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 02 (see p. 52 for session)

Stecca, Giuseppe *(University of Rome Tor Vergata)*
Bernardi, Daria *(Institute of Industrial Technology and Automation - National Research Council, Rome)*
Carotenuto, Pasquale *(Institute of Industrial Technology and Automation - National Research Council, Rome)*

A Negotiation Protocol for E-Procurement Process

Internet based technologies enable the changing of almost all enterprise processes. In recent years, the processes more affected by information technologies are inter enterprise processes as procurement and order fulfillment process. E-procurement solutions provided by big software houses have been adopted by more and more enterprises. Most of medium and small enterprises have to face very specific processes and a problem issued by this kind of enterprises is that, in most cases, the e-procurement tools provided by vendors require strong changes in the business processes that sometimes not follow performance criteria; the technological and infrastructural aspect often constrains and puts in shadow the logical aspect. To face this problem new paradigms have to be used.

We study the procurement process under a multiagent view in which actors involved in the business process are interpreted as agents. These agents have decisional ability and communicate in way to absolve the procurement process and to negotiate and purchase goods. In order to absolve the negotiation process, agents need a communication infrastructure, a communication protocol, a negotiation protocol, and a decisional strategy.

In this paper we review negotiation protocols, propose a negotiation protocol applied to e-procurement process, and tested in the kitchen supply market. In the multiagent view, the e-procurement process is schematized as a distributed decisional process representing the enterprise network. The case study reflects a private market place environment in which a medium sized customer is involved in procurement process with a set of small sized suppliers. We also propose and evaluate a decision strategy for the customer that could be applied in the case study. The experimentation phase has been done with real supplier data used to simulate different supplier behaviors and typologies, and to test and evaluate the negotiation protocol.

Thursday, Sep. 4, 2003, 13:30 – 15:30, Room: NU 02 (see p. 52 for session)

Stecca, Giuseppe *(University of Rome Tor Vergata)*
Bernardi, Daria *(Institute of Industrial Technology and Automation - National Research Council, Rome)*
Confessore, Giuseppe *(Institute of Industrial Technology and Automation - National Research Council, Rome)*

A Multi-Agent Model to Improve SMEs E-Procurement Process

The competitive position of an Enterprise is mainly depending from its capability to involve in its own business the suppliers, the partners, the customers and the subcontractors starting from the Product Lifecycle and till the systems for the Supply Chain Management and the Customer Relationship Management; in this perspective a new value chain is built up. This issue represents one of the reasons why the enterprises are focusing on the evaluation of Internet based solutions and are carrying out this task by searching the front office/back office integration.

The topic of this work is to study an e-procurement solution to allow the optimisation of the purchasing processes for the SMEs. In general the e-procurement tools are too expensive for the SMEs and, in any case, they have such specific processes and problems that the introduction of this tools results very difficult. The main object of the work is to give a distribuited decision system description for the SMEs procurement process using a multi-agent model. The improvement of the procurement process performance occur through a private market place solution in which the enterprise can allow the optimisation of the purchasing processes through the integration of the suppliers with the enterprise in way to reduce the purchase costs and the time to market, furthermore to increase the process efficiency. The SMEs network can use a negotiation platform as a comunication infrastructure.

In this paper, we design a multi-agent architecture in order to describe the procurement process and decide the role and the constrains to guide the interactions among the agents.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 02 (see p. 40 for session)

Suhl, Leena *(Decision Support and Operations Research, University of Paderborn)*
Biederbick, Claus *(Decision Support and Operations Research, University of Paderborn)*
Goecke, Johannes *(Decision Support and Operations Research, University of Paderborn)*

A Decision Support System for Recovery Management in Public Transport

Recovery management in complex networks of public transport has recently become an important area for applying up-to-date optimization and simulation technologies. We present a system architecture and an Internet-based realization of

a distributed agent-based simulation environment, capable of including the complete long-distance network of German Railways, as an example. Individual trains and passengers are represented by software agents, being able to follow their own goals and re-act appropriately in case of disruptions. Thus, a recovery strategy is constructed gradually through local considerations. We present simulation results with a large number of passengers, with the goal of minimizing passenger dissatisfaction.

Wednesday, Sep. 3, 2003, 13:30 – 15:30, Room: NU 02 (see p. 40 for session)

Trinkaus, Hans L. *(Fraunhofer Institute for Industrial Mathematics, Kaiserslautern)*

A Knowledge Box for Dynamic Multicriteria Decision Support

In this talk will be presented a novel multicriteria decision support system called Knowledge Box, which consists of the following components:

1. The Knowledge Organisation rests upon a database, where each data block contains some qualitative and/or quantitative criteria values, together with some add on information attachments.
2. The Knowledge Generation component supports filling the database by various techniques such as identification, optimisation, classification or simulation - depending on the multi criteria system's nature. The knowledge generation may be done by batch computations, interactively, and with a by-and-by refinement.
3. The Knowledge Navigation component serves "finding a needle in a haycock". Among the tools and features for coping with a possibly huge amount of data are the following ones:
    - A tricky graphical navigation tool supports and controls the interactive, goal-oriented exploration of the database. Personally customisable visualizations facilitate the work of the decision maker by their intuitive and ergonomic interface - showing various criteria aggregations in a cascading manner and corresponding information attachments at the same time.
    - Quantitative and qualitative criteria, of arbitrary number, may be handled simultaneously, each user may look and select for her/his priorities or preferences, based e.g. on aspiration levels.
    - The tool is "open" for user specific retrieval strategies. Metrics on the database are modifiable, entry points to and navigating tours through the data base may be changed or adapted any time, without loss of experience gained so far - and without any obstacles against trying several alternatives, too. So every decision maker is free in finding his/her own selection (path).

The application of the Knowledge Box is illustrated by some projects already done in practise, e.g. in industrial engineering and in the life sciences.
