GOR

Gesellschaft für Operations Research e.V.

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76. Sitzung der GOR Arbeitsgruppe

Praxis der Mathematischen Optimierung
Financial Optimization and Optimal Pricing Strategies

BASF Aktiengesellschaft, Ludwigshafen, May 22-23, 2006

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AGENDA

Praxis der Mathematischen Optimierung
Financial Optimization and Optimal Pricing Strategies

BASF Aktiengesellschaft, Ludwigshafen, Germany, May 22/23 – 2006
Building: C100, Room 6.15

Monday, 22.05.2006 : 14:00 – 18:00

14:00-14:10 Opening and Greetings (J. Kallrath / A. Lavrov, K. Hahn / A. Schreieck)

14:10-15:00 **Thomas Breuer** (FH Vorarlberg, Dornbirn, Austria)
Portfolio-Selection with Generalized Multi-period Risk Measures

15:00-15:50 **Michael Bussieck & Franz Nelissen**, GAMS GmbH, Köln, Germany
Portfolio Optimization: A Technical Perspective

15:50-16:20 -------------------------- Break ---------------------------------

16:20-17:10 **Marc Steinbach**, FH Vorarlberg, Dornbirn, Austria
Stochastic Programming Models and Algorithms for Electricity Swing Options

17:10-18:00 **Gerard DeBeuckelaer**, UTI SN, Bucharest, Romania & Kapellen, Belgien
Pricing

Conference Dinner

(HolzWeisbrodt WeinArtrium, Weisenheim am Berg)

18:30-19:30 **Wine Testing (6 courses) hosted by GOR**
19:30-22:00 **Conference Dinner**

Tuesday, 23.05.2006 : 09:30 – 16:00

09:30-10:20 **Panos Pardalos**, University of Florida, Gainesville, FL, USA
Dynamics of the Financial Market

10:20-10:40 -------------------------- Break --------------------------------

10:40-11:30 **Ralf Korn** (TU Kaiserslautern & ITWM Kaiserslautern, Germany)
Optimal Portfolios: New Variations of an Old Theme

11:30-12:20 **John Schoenmakers**, Matheon Berlin, Germany
Iterative Methods for Complex Structured Callable Products

12:20-13:30 -------------------------- Break --------------------------------

13:30-14:30 **Werner Römisch**, Humboldt-University-Berlin, Berlin, Germany
Applications of Stochastic Programming in Electricity Portfolio and Airline Revenue Management

14:30-14:50 -------------------------- Break --------------------------------

14:50-15:50 **Christodoulos A. Floudas**, Princeton University, Princeton, NJ
A Novel and Effective Integer Optimization Approach for the Panel Assignment Problem: A Multi-Resource and Preference-Constrained Generalized Assignment Problem

15:50-16:00 **Final Discussion**

Portfolio Selection with Generalised Multi-Period Risk Measures

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Coherent multi-period risk measures have been introduced recently by Artzner, Delbaen, Eber, Heath, and Ku 2002 (www.risklab.ch/ftp/papers/CoherentMultiPeriodRM.pdf). In contrast to one-period risk measures in a multi-period context one has to take into account the availability of additional information at intermediate times and the possibility of intermediate buy and sell actions and of capital in- or outflows. Artzner *et al.* prove a representation theorem: For each coherent multi-period risk measure there is a set $\mathcal{A}$ of generalised scenarios (probability measures) such that the risk of each portfolio is the maximum expetected loss over all probability measures in $\mathcal{A}$. Their multi-period risk measures are based on probability measures and not on point scenarios. Therefore Maximum Loss over point scenarios is not tractable in this framework.

We propose a generalised concept of multi-period risk measure which also allows for point scenarios and therefore includes Maximum Loss. To illustrate the usefulness of this concept we show that traditional one-period coherent risk measures such as Expected Shortfall or Maximum Loss are special cases. Furthermore we specify the optimisation problem of choosing the optimal portfolio rebalancing strategy, which is involved in the calculation of multi-period risk.

Portfolio Optimization: A Technical Perspective

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Portfolio Optimization, based on the mean-variance paradigm introduced 1952 by Harry Markowitz is one of the success stories in financial optimization and is widely used in practice.

Real world investors are interested in extending the basic mean-variance approach with restrictions such as cardinality constraints, limiting the number of trades, defining a minimum level of trade for an asset, reducing taxation costs, etc. The resulting models are quite complex and thus lots of efforts went into algorithmic work in the past. Nowadays the emphasis is more on modeling aspects but there are still problem instances, which are difficult or time consuming to solve.

We will start with a basic mean variance model and extend it with some real world constraints. Finally we will show some extensions, which now allow to solve large sets of scenarios using grid computing facilities with only minor modifications to the structure of the model.

Pricing

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Pricing is a simple concept, until you start to think about it. There are a number of prejudices that we need to throw over board. For instance the idea that price has anything to do with cost. It does not! Cost is our problem, and price is what the market is willing to give for our product.

There are micro-economic theories about pricing, but they are largely qualitative. But somewhere, on the price scale, there must be an optimum that offers us the maximum cash flow. To find that optimum will be devilishly difficult, but also extremely rewarding.

One promising avenue is to know the economics of your customer, knowing the economic impact of our product.

A Novel and Effective Integer Optimization Approach for the Panel Assignment Problem: A Multi-Resource and Preference-Constrained Generalized Assignment Problem

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The panel assignment problem can be viewed as an enhanced version of the generalized assignment problem (GAP), which has been the subject of considerable research over the last twenty years. The GAP has many real-life applications including job scheduling, production planning, modeling of computer and communication networks, storage space allocation, vehicle routing, and facility location problems. The GAP seeks to determine the minimum cost assignment of n jobs to m agents so that each job (j) is assigned to exactly one agent (i) subject to resource restrictions on the agents. The GAP can be formulated as follows

$$\begin{aligned} Min \quad & \sum_{i \in I} \sum_{j \in J_i} c_{i,j} x_{i,j} \\ s.t. \quad & \sum_{j \in J_i} a_{i,j} \cdot x_{i,j} \leq b_i \ \ \forall i \in I \\ & \sum_{i \in I_j} x_{i,j} = 1 \ \ \forall j \in J \\ & x_{i,j} = \{0,1\} \ \ \forall i \in I, \ \ j \in J_i \end{aligned} \tag{1}$$

where $c_{i,j}$ is the cost of assigning job (j) to agent (i), $a_{i,j}$ is the amount of resource consumed by job (j) when assigned to agent (i), and b_i is the resource availability of agent (i). The binary assignment variable $x_{i,j}$ equals 1 if agent (i) is to perform job (j), and equals 0 otherwise.

The panel assignment problem studied in this work involves selecting an assignment of three or four reviewers to each proposal in a panel so as to optimize the sum of a set of preference criteria for each reviewer on each proposal while ensuring that each reviewer is assigned to approximately the same number of proposals. In addition, each proposal has three or four distinct positions that are assigned to reviewers based upon the preference criteria so that each reviewer holds each position approximately the same number of times. This multi-resource and preference-constrained generalized assignment problem can be formulated as an integer linear programming problem and can be solved to optimality. In this work, a mathematical model is developed to address the panel assignment problem and some representative example problems are solved to demonstrate the effectiveness of the proposed approach.

Optimal Portfolios: New Variations of an Old Theme

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Starting from standard results for optimal investment in the Black-Scholes setting various modifications and generalizations will be presented. These include the optimal investment with derivatives, optimal investment with defaultable securities and optimal investment with crashes and unhedgeable risks. To solve the corresponding optimization problems methods of dynamic programming and the martingale method especially developed for complete financial markets will be used.

Dynamics of the Financial Market

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We consider a recently introduced network-based representation of the U.S. stock market referred to as the market graph. This graph has been shown to follow a power law, which is characteristic for a variety of real-world complex systems. We discuss approaches to identifying clusters of similar stocks in the market by partitioning the market graph. In particular, identifying connected components in the market graph provides a computationally efficient technique for solving this problem. It turns out that the found connected components have specific structure, where each cluster corresponds to certain industrial segments. Moreover, the size of these connected components is consistent with the theoretical properties of the power-law model.

References

[1] J. Abello, P.M. Pardalos, and M.G.C. Resende (eds.), 2002. Handbook of Massive Data Sets, Kluwer Academic Publishers.

[2] V. Boginski, S. Butenko, and P.M. Pardalos, Statistical Analysis of Financial Networks, Journal of Computational Statistics and Data Analysis, Vol. 48, Issue 1 (2005), pp. 431-443.

[3] V. Boginski, S. Butenko, and P.M. Pardalos, Mining market data: A network approach, Computers & Operations Research Volume 33, Issue 11 (2006), pp. 3171-3184.

Applications of Stochastic Programming in Electricity Portfolio and Airline Revenue Management

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We consider mixed-integer multi-stage stochastic programs and show that typical electricity portfolio optimization and O&D airline revenue management models are of this form. We discuss the theoretical and numerical challenges of multi-stage models and put emphasis on generating scenario trees for approximating the stochastic input process and on a dual decomposition scheme based on Lagrangian relaxation of coupling constraints. The incorporation of multiperiod risk functionals that are compatible with the decomposition is also discussed. Numerical results from both application areas are presented.

Iterative methods for complex structured callable products

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We present a new iterative procedure for solving the discrete optimal stopping problem. By this procedure we are going to price callable financial products. The method produces monotonically increasing approximations of the Snell envelope from below, which coincide with the Snell envelope after finitely many steps. Then, by duality, the method induces a convergent sequence of upper bounds as well. Contrary to backward dynamic programming, the presented iterative procedure allows to calculate approximative solutions with only a few nestings of conditionals expectations and is, therefore, tailor-made for a plain Monte-Carlo implementation. The power of the procedure is demonstrated for high dimensional Bermudan products, in particular, for Bermudan swaptions in a full factor Libor market model.

Stochastic Programming Models and Algorithms for Electricity Swing Options

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Electricity swing options are derivative contracts in energy markets designed as hedging instruments against spot price risk. The holder obtains the right to purchase a specified amount of energy at a predetermined price during a certain period of time. His consumption process is flexible within agreed limits, yielding a payoff structure that depends on the exercise strategy. Because of uncertain future prices, valuating a swing option thus requires the solution of a stochastic dynamic optimization problem. Based on a report by Haarbrcker and Kuhn (U St. Gallen, 2005), we present suitable stochastic programming models and analyze the theoretical properties. We also present solution algorithms that exploit the underlying scenario tree structure, and demonstrate their efficiency with computational results.

76th Meeting of the GOR Working Group

„Praxis der Mathematischen Optimierung“

Financial Optimization and Optimal Pricing Strategies

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Portfolio Selection with Generalised Multi-Period Risk Measures

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[1] * = Non GOR-member, *italic* = speaker (35 participants incl. 9 speakers and 2 CLs, **; +15 persons BASF)

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Portfolio Optimization: A Technical Perspective

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A Novel and Effective Integer Optimization Approach for the Panel Assignment Problem: A Multi-Resource and Preference-Constrained Generalized Assignment

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Optimal Portfolios: New Variations of an Old Theme

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Portfolio Optimization: A Technical Perspective

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Dynamics of the Financial Market

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Applications of Stochastic Programming in Electricity Portfolio and Airline Revenue Management

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Iterative Methods for Complex Structured Callable Products

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