
82nd Meeting of the GOR Working Group

Praxis der Mathematischen Optimierung
("Real World Optimization")

Mathematical Optimization in Logistics

psb intralogistics GmbH, Pirmasens, Germany, 2.-3. April 2009
(www.psb-gmbh.de)

Organization

Josef Kallrath & Alexander Lavrov
GOR AG „Praxis der mathematischen Optimierung“

&

Ulrich Russ
psb intralogistics GmbH, Pirmasens

Mathematical Optimization in Logistics

Optimization has become an indispensable technique in developing complex logistics systems or solving any logistics problems of practice-relevant complexity. In such applications, optimization appears either as a stand-alone technology (based on rigid or heuristic methods) or in combination with other techniques, such as simulation.

This workshop will give an overview about the state-of-the art technologies illustrated by real-world applications.

In 12-14 talks, each approx. 30-45 minutes, experts from practice, research institutions or software companies, will present selected problems and the corresponding solutions.

Particular attention will be paid to contributions from industry and industry research solving the problems in their field using optimization or optimization&simulation techniques.

A list of speakers who already agreed to present a talk includes (sorted alphabetically):

- Dr. Frans de Rooij (Paragon Decision Technology BV, Haarlem, The Netherlands)
"Optimization of industrial logistics networks with AIMMS"
- Prof. Dr. Thomas Hanne (Fachhochschule Nordwestschweiz)
"Multiobjective Evolutionary Algorithms and Preference-Based Decision Support for Staff Rostering in a Logistics Company"
- Dipl.-Inf. Ralf Helfgen (InCom Gesellschaft für EDV-Systeme mbH, Schiffweiler)
„Store Strategy for Long Trolley“ („Einlagerstrategie Long Trolley“).
- Dr. Axel Helfrich & Dipl.-Inf. Christian Krüger (psb intralogistics GmbH, Pirmasens)
„Material Handling Engineering: Optimization and Simulation of Stacker Crane Throughput“
- Prof. Dr. Siegfried Jetzke (FH Braunschweig/Wolfenbüttel)
"Optimization and Simulation of Store Delivery and Private Freight Traffic"
- Dr. Thomas Kalinowski (Universität Rostock)
"Exact Minimization of the Number of Split Deliveries in Mail Order Logistics"
- Prof. Dr. Sven O. Krumke (Universität Kaiserslautern)
"Online Optimierung in der innerbetrieblichen Logistik"
(„Online Optimization in the Intra-Plant Logistics“)
- Prof. Dr. Stefan Nickel & Dr. Jörg Kalcsics (Universität des Saarlandes, Saarbrücken)
"Order Penetration Point Bestimmung – Eine Fallstudie"
("Determining an Order Penetration Point: A Case Study")
- Dipl.-Math. Torsten Schneider (HERMES Logistik Gruppe, Hamburg)
"Kopplung von Materialfluss-Simulation und Tourenplanung in einem mehrstufigen Distributionssystem"
(“Combining of Material Flow Simulation and Route Planning in a Multistage Distribution System“)
- J. Schüssler (J.S. Logistik AG, Kirkel), Prof. Dr. Th. Boussonville & Prof. Dr. T. Melo (Hochschule für Technik und Wirtschaft des Saarlandes, Saarbrücken)
"Unterstützung dynamischer Dispositionsaufgaben im Güterkraftverkehr".
- Dr. Sven Spieckermann (SimPlan AG, Maintal)
"Lagerlogistische Simulation und Optimierungsprobleme - Erfahrungsbericht und Fallbeispiele".
(„Warehouse Simulation and Optimization Problems: Experience Reports and Case Studies“)
- Prof. em. Dr.Dr.h.c.mult. H.-J.Zimmermann (INFORM GmbH, Aachen)
"Optimale Logistiksteuerungen in Häfen, Flughäfen und Krankenhäusern"
(„Optimal Logistics Control in Harbors, Airports and Hospitals“)

Further contributions are welcome if they describe techniques or problems relevant for optimization in logistics. In particular, we look forward for practice-oriented application examples and case studies where optimization problems have been solved rigidly using mathematical optimization methods.

As a part of the event program, a guided tour through the company psb intralogistics GmbH will be organised. In addition, a guided tour through a Science Center Pirmasens „Dynamikum“ will be offered to the participants.

82. Sitzung der GOR Arbeitsgruppe

Praxis der Mathematischen Optimierung
Mathematical Optimization in Logistics

psb intralogistics GmbH, Pirmasens, Germany, 2.-3. April 2009

Thursday, 02.04.2009 : 13:30 –22:30

- 13:30-13:45 Opening and Greetings
(**Josef Kallrath** (GOR), **Ludwig Peetz** (FH KL), **Ulrich Russ** (psb))
- 13:45-14:00 Brief presentation of *psb intralogistics GmbH* (**Ulrich Russ**)
- 14:00-15:00 **Hans-Jürgen Zimmermann**, INFORM GmbH, Aachen
Optimal Logistics Control in Harbors, Airports and Hospitals
- 15:00-15:35 **Thomas Hanne**, Fachhochschule Nordwestschweiz
Multiobjective Evolutionary Algorithms and Preference-Based Decision Support for Staff Rostering in a Logistics Company
- 15:35-15:55 ----- *Coffee Break* -----
- 15:55-16:30 **Sven O. Krumke**, Universität Kaiserslautern
Online Optimization in the Intra-Plant Logistics
- 16:30-17:05 **Ralf Helfgen**, InCom Gesellschaft für EDV-Systeme mbH, Schiffweiler
Store Strategy for Long Trolley
- 17:05-17:40 **Th. Bousonville & T. Melo** (Hochschule für Technik und Wirtschaft des Saarlandes, Saarbrücken), **J. Schüssler** (J.S. Logistik AG, Kirkel),
Exploring telematics data for performance evaluation and decision support in long-haul freight transportation

Conference Evening

- 17:45 Departure to the Science Center Pirmasens „Dynamikum“
- 18:00-19:00 Guided tour through Science Center Pirmasens „Dynamikum“
- 19:15-19:30 Guided walk to the town center
- 19:30-22:30 Conference dinner in Brauhaus Kuchems, with a possible bierprobe
- 22:30 Shuttle departure to Hotel Kunz

Friday, 03.04.2009 : 09:30 – 17:00

09:30-10:15 **Sven Spieckermann**, SimPlan AG, Maintal

Warehouse Simulation and Optimization Problems: Experience Reports and Case Studies

10:15-10:50 **Axel Helfrich & Christian Krüger**, psb intralogistics GmbH, Pirmasens

Material Handling Engineering: Optimization and Simulation of Stacker Crane throughput

10:50-11:25 **Frans de Rooij**, Paragon Decision Technology BV, Haarlem, The Netherlands

Optimization of industrial logistics networks with AIMMS

11:30-12:30 ---- ***Guided tour through psb intralogistics GmbH***

12:30-14:00 ---- Lunch Break -----

14:00-14:35 **Siegfried Jetzke**, Fachhochschule Braunschweig/Wolfenbüttel

Optimization and simulation of store delivery and private freight traffic

14:35-15:10 **Thomas Kalinowski**, Universität Rostock

Exact minimization of the number of split deliveries in mail order logistics

15:10-15:30 ---- Coffee Break -----

15:30-16:05 **Stefan Nickel & Jörg Kalcsics**, Universität Karlsruhe (TH), Karlsruhe

Determining an Order Penetration Point: A Case Study

16:05-16:40 **Torsten Schneider**, HERMES Logistik Gruppe, Hamburg

Combining of Material Flow Simulation and Route Planning in a Multistage Distribution System

16:40-17:00 **Final Discussion**

The Speakers

Thomas Bousonville received his Ph.D. from the University of Bremen in 2001 for work on the application of Evolutionary Algorithms to routing problems. After research on metaheuristics during his postdoctoral studies he joined the R&D department of ILOG where he was working on production planning and scheduling problems. Since 2006 he is a professor in logistics and information systems at the Saarland University of Applied Sciences (HTWdS). His research interests lie in the application of quantitative methods on logistical problems and the supporting use of information technology.

Frans de Rooij works at Paragon Decision Technology in the Netherlands, where he is responsible for the European sales & marketing of the AIMMS mathematical modeling system. Frans previously worked as a consultant at Arthur D. Little and at Corus Steel. He has an MSc in physics from Eindhoven University of Technology (NL) and a PhD in applied mathematics from the University of Cambridge (UK).

Thomas Hanne received a masters degree in Economics from Ruhr-University Bochum, a masters degree in Computer Science from University Dortmund, and a PhD in Economics from FernUniversity Hagen. From 1999 to 2007 he worked at the Fraunhofer Institute for Industrial Mathematics (ITWM) in the Department of Optimization as senior scientist. Since then he is Professor for Information Systems at the University of Applied Sciences Northwestern Switzerland. Thomas Hanne is author of about 50 journal and conference articles. His current research interests include multicriteria decision analysis, evolutionary algorithms, metaheuristics, scheduling, discrete-event simulation, ERP systems, logistics, and supply chain management.

Axel Helfrich is a technical engineer who studied at the University of Kaiserslautern and obtained his PhD in 1995. He currently works for the technical integration and development department at psb intralogistics GmbH. His main focus of work is the design and optimization of stacker cranes. Since 2007 he is convenor of the WG5 "Rail dependent storage and retrieval equipment" EN528.

Siegfried Jetzke is professor for *Technische Grundlagen und Logistik* at the *Fachhochschule Braunschweig/Wolfenbüttel* and head of *goodSync*, a small company that develops and applies software for improving logistical processes. He studied physics and mathematics and received his doctoral degree in theoretical physics with a work on nonlinear processes in laser-atom-interactions. Before becoming engaged in logistics he worked on simulation and optimization problems in genetics as well as transportation problems of nuclear particles. Nowadays he feels to be positioned between the practitioner in production or logistics and the theoretician. His main interest is to find proper descriptions for real life problems with quite often many actors with competitive goals such that available techniques can be applied. The theoretical question he is interested in is very simple: A given number of goods have to be brought to the right place at the right time with a given number of resources and constraints such that a given quality function is minimized.

Jörg Kalcsics studied mathematics at the University of Kaiserslautern. Afterwards he worked for three years at the Fraunhofer Institut für Techno- und Wirtschaftsmathematik (ITWM) in Kaiserslautern. Since 2003 he is employed at the Chair for Operations Research and Logistics at the Saarland University, where he also received his PhD. His fields of research focus on location problems, combinatorial optimization as well as strategical and tactical supply chain management.

Thomas Kalinowski is a postdoc at the University of Rostock. He received his PhD in 2005 on a combinatorial optimization problem arising in radiation treatment planning for cancer therapy. These results are currently further developed in a joint project with the University Medical Center Hamburg-Eppendorf. His research interests include applications of combinatorial optimization, especially network flow methods, but also extremal combinatorics and graph theory.

Christian Krüger studied Computer Science at the University of Applied Sciences Kaiserslautern and received his diploma degree in 2005. He currently works for the IT System Design department at psb intralogistics GmbH. His main scope of work is set on the simulation of intralogistic systems including the analysis and optimization.

Teresa Melo is professor of mathematics and statistics at the Department of Business Administration of the University of Applied Sciences Saarland (HTW), Germany. Prior to joining HTW, she worked at the Fraunhofer Institute for Industrial Mathematics (Germany), where she was the head of the "Supply Chain Management" and "Hospital Logistics" working groups. She has conducted a number of industrial and publicly funded projects and has wide experience in the development of optimization models and methods for solving real-world problems from different industries. Her research interests include facility location in strategic supply chain planning, health care logistics as well as routing and distribution problems. She holds a PhD in Operations Research from the Erasmus University Rotterdam (The Netherlands).

Sven Spieckermann studierte Wirtschaftsinformatik an der TU Darmstadt und schrieb seine Dissertation an der TU Braunschweig. Er ist seit mehr als zehn Jahren als Berater und Projektleiter für Simulation bei der SimPlan Gruppe tätig und leitet heute als Vorstand gemeinsam mit Dirk Wortmann die SimPlan AG. Er verantwortet hier insbesondere das Controlling und die Finanzen des Unternehmens.

Als Lehrbeauftragter für Simulation an der TU Braunschweig und der TU Darmstadt gibt Herr Spieckermann sein Wissen und seine Erfahrungen an Studenten weiter und veröffentlichte zahlreiche Beiträge in diversen Fachzeitschriften.

Hans-Jürgen Zimmermann was Chairman of the Department for Operations Research at the Aachen Institute of Technology from 1967 till 1999. He is Scientific Director of ELITE (European Laboratory for Intelligent Techniques Engineering) and Scientific Adviser of INFORM.

He received his Bachelor in Engineering from Darmstadt Institute of Technology, his Masters in Engineering and his Ph.D. in Mathematical Economics and Business Administration from the Technical University of Berlin. After having held various positions in industry, he was Professor at the University of Illinois and has been teaching at various universities in India, Europe and the USA. He received his first Honorary Doctorate from the Free University of Brussels and his second Honorary Doctorate from the Abo Akademi University, Finland. In 1985 he received the EURO Gold Medal, the highest distinction in Operations Research in Europe, the K.S. Fu Certificate of Appreciation, the highest distinction of the "North American Fuzzy Information Processing Society" and in 1993 the Moisil Prize and Gold Medal. In 1997 he received the Kaufmann Prize:Gold Medal for Excellence in Uncertainty Research in Management, and in 1998 the EURO Pass in Gold. In 1999 he received the "European Pioneers Award" for pioneering research from EUSFLAT, the "Special Certificate of Merit" from IFSA and became Fellow of IFSA and the first Honorary Member of GOR, the German Operations Research Society.

He has published more than 240 papers in the areas of Operations Research, Decision Theory, and Fuzzy Set Theory and 35 books in English and German in similar areas. He was Editor-in-Chief of the International Journal for Fuzzy Sets and Systems and Editor of the European Journal for Operational Research, from 1978 till 1999 and is Editor of the book series International Series in Intelligent Technologies, and Editor or Co-Editor of another 12 International Journals.

He has been President of the German Operations Research Society, the European Association of Operational Research Societies, IFSA (International Fuzzy Systems Association), the German Industrial Engineering Society, and EEMA (European Engineering and Management Associations). He has also been Vice President of IFORS (International Federation of Operational Research Societies) and some other professional associations. Dr. Zimmermann has been organizer or chairman of numerous national and international conferences. In 2007, INFORM GmbH, founded by Professor Zimmermann in 1969, became the first enterprise awarded with the GOR-Company Price.

He has been actively pursuing research in fuzzy set theory and its applications since 1972. His current research interests include fuzzy mathematical programming, fuzzy control, fuzzy expert systems, fuzzy data analysis, and their application to various areas, such as, strategic planning, managerial decision making, concurrent engineering, etc. He is supervising a number of industrial projects, in which these methods are applied to industrial problems. He consults and supports INFORM in project work.

Optimization of Industrial Logistics Networks with AIMMS

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AIMMS is a modeling system that can bridge the gap between theoretical optimization concepts and operational practices, making it easy to develop and deploy optimization models in industry.

To develop an accurate model of a real-life situation, AIMMS offers an integrated model development environment that links seamlessly to many mathematical solvers for linear, integer and nonlinear problems. Advanced modeling concepts are available, such as rolling horizons, automatic generation of Stochastic Programs and Benders decomposition.

To deploy these optimization models operationally, AIMMS offers the capability to construct a graphical user interface around the model and to link it to various data sources. One could also choose to use the AIMMS model as a component, functioning as an "optimization engine" behind existing IT applications.

We will illustrate the use of AIMMS to optimize industrial logistics networks with two cases from industry:

The first case is the SCM optimization tool that AIMMS Service Partner OptaSoft has developed for Provimi, one of Europe's largest pet food companies. The tool optimizes the transport between production lines, packaging lines and customers for more than 800 products across 17 countries.

The second case is the nationwide distribution network optimizer developed by Horoz Logistics for a large producer of fertilizer. The AIMMS application takes into account some 80,000 truck movements per year and generated an annual cost saving of approximately US\$ 400,000.

Exploring telematics data for performance evaluation and decision support in long-haul freight transportation

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The globalization of the economy as well as growing demand for customer-driven production and distribution networks have contributed to a significant increase in the demand for transportation in the last decades. In particular, road transportation dominates the movement of freight in Europe. A key issue in freight operations is the recent legislative framework enforced by the European Union (EU). New EU regulations on drivers' working hours have a strong impact on freight routes and consequently on freight costs. We will show how information provided by vehicle telematics can be used to evaluate the compliance of freight operations with the new legal framework. In addition, we will describe how telematics and online data can be processed into timely and meaningful information and advice for advance planning and management processes.

Multiobjective Evolutionary Algorithms and Preference-Based Decision Support for Staff Rostering in a Logistics Company

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We discuss a real-life problem in personnel rostering for logistics companies. Specific emphasis is placed on the requirements of advanced approaches in rostering and the usage of optimization-based decision support. The modeling of the rostering problems is discussed including the treatment of constraints, the consideration of preferences, and the formulation of several objective functions. The specific solving method of the problem using an evolutionary algorithm is sketched briefly. Visualization and navigation tools for decision support are discussed as well and some preliminary results are shown. Finally, some conclusions are presented.

Optimization and Simulation of Store Delivery and Private Freight Traffic

Siegfried Jetzke

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In this talk we will describe our model for simulating and optimizing transportation processes in logistics together with two real life applications. This model can be used for transportation problems on public roads as well as for factory premises. We will outline requirements, concerning data and defining goal and restrictions, and possibilities starting from the operational down to the strategic level. We have implemented simulation and optimization algorithms to solve real world problems. These have been applied together with industrial partners: The delivery of more than 300 stores has been planned. Two depots, time windows, working times of the drivers and load restrictions are taken into account. The delivery is twice a week but not on two subsequent days. In a second project we have considered the supply of a big plant with some hundred trucks a day. Time windows were determined by optimization, best traffic rules by time dependent simulation. We will give an outlook how these two different aspects of the distribution or supply problem can be combined.

Determining an Order Penetration Point: A Case Study

Jörg Kalcsics, Tobias Kraus, Cornelia Liebel, Stefan Nickel, Hans-Peter Ziegler

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We consider a medium-sized company with a multi-level production system which currently follows a classical make-to-stock policy. The company intends to move the order penetration point downstream in the production process for several products, that is, it wants to switch from a pure make-to-stock to a make-to-assemble or make-to-order policy. Before implementing such a long run decision, the resulting consequences for the company have to be considered thoroughly. To that end, our study focuses on two major issues: First of all, moving the order penetration point downstream will likely reduce the inventory levels as well as the safety stocks, and thereby the inventory holding costs. At the same time, handling costs may increase. Therefore we analyze which products may be beneficial from a financial point of view. Secondly, due to the still pending production and/or assembly steps after an order for a finished product is received, the delivery delays may increase to an unacceptable level. We analyze this problem by means of a discrete event simulation.

Exact Minimization of the Number of Split Deliveries in Mail Order Logistics

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The avoidance of split deliveries is an important problem in mail order logistics. If the customer requests are satisfied from several storehouses, a natural objective is to minimize the number of orders that have to be split between different storehouses. The obvious integer programming formulation of this problem cannot be handled directly with a standard solver if the instance has a size of practical relevance. We propose a twofold approach. Firstly, a heuristic start solution can be improved by solving certain network flow problems. Secondly, the generation of certain valid inequalities (lifted cover inequalities) leads to strong LP relaxations, whose solutions yield good lower bounds on the number of splits. Using some more network flow problems, the solutions of the relaxed problems can be used to derive further valid inequalities. Iterating this procedure we get an algorithm for computing a feasible delivery plan, and by adding integrality constraints in a late phase of the algorithm, we even get the exact optimum.

In the talk we discuss the algorithmic principles underlying our method, and we present some computational results, which show that a good implementation of the algorithm can indeed solve real world problems to optimality in a few minutes.

Online Optimierung in der innerbetrieblichen Logistik

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Die Automatisierung von innerbetrieblicher Logistik erfordert – über die physikalische Steuerung von Geräten hinaus – auch eine effiziente Organisation der Transporte: ein Aufgabenfeld der kombinatorischen Optimierung. Der Vortrag illustriert anhand von konkreten Aufgabenstellungen (Aufzugsteuerung, Kommissionierung, Hochregallager-Organisation, etc.) die Online-Problematik (unvollständiges Wissen) sowie die Echtzeit-Problematik (beschränkte Rechenzeit), auf die man in der innerbetrieblichen Logistik trifft. Wir stellen allgemeine Ansätze für Online-Algorithmen vor und zeigen, wie man die Güte von solchen Verfahren theoretisch und praktisch misst.

Kopplung von Materialfluss-Simulation und Tourenplanung in einem mehrstufigen Distributionssystem

Torsten Schneider
HERMES Logistik Gruppe
Hamburg

Typische Distributionsnetze von KEP-Dienstleistern weisen eine Komplexität auf, die auf strategischer Ebene den Einsatz adäquater Planungswerkzeuge notwendig macht. In diesem Vortrag soll ein Softwaresystem vorgestellt werden, das Prozess-Simulation, Tourenplanung, Standortoptimierung sowie GIS-Komponenten integriert, um prozessbergreifende Optimierungspotentiale zu erkennen und zu realisieren.

Lagerlogistische Simulation und Optimierungsprobleme - Erfahrungsbericht und Fallbeispiele

Sven Spieckermann

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Das Ziel des Vortrags wäre am Beispiel von Praxisprojekten aufzuzeigen, wo sich "Brücken" zu mathematischen Optimierungsproblemen ergeben und wie im jeweiligen konkreten Projektkontext dann damit umgegangen worden ist.

Optimal Logistics Control in Harbours, Airports and Hospitals

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Even though we are here talking about transportation logistics, tasks that can and should be optimally controlled are not only routing problems but quite a number of problems that one would not necessarily expect in the logistics environment. In three application areas, e.g. airports, terminals and hospitals, such problems and their solutions will be described.