GOR
Gesellschaft für Operations Research e.V.

Kackertstr. 7 52072 Aachen Tel.: +49 (0) 241 80 23830 Fax: +49 (0) 241 6 80 23830

GOR-Arbeitsgruppe:
Praxis der Mathematischen Optimierung
Dr. Jens Schulz
Fontaneweg 15
D-16547 Birkenwerder

Mail: schulz-gor@gmx.net

Herewith, we invite you to the 103rd meeting of the GOR working group “Real World Optimization” at Fraunhofer ITWM Kaiserslautern. This meeting is hold as a symposium with the topic

Multicriteria Optimization and Decision Support in Industry

The workshop takes place on November 21st & 22nd, 2019 on Thursday and Friday.

The working language will be preferably English, since some speakers or participants are expected from abroad.

Note that the participation in a GOR-AG-Workshop for non-members is subject to a registration fee, unless you are a speaker or a host.

Please register yourself online using https://www.redseat.de/pmo103/. The registration will be possible from May till October 2019. The latest information on the meeting is available on the homepage of the GOR (http://www.gor-ev.de/arbeitsgruppen/praxis-der-mathematischen-optimierung).

Yours sincerely,

Karl-Heinz Küfer
(Fraunhofer ITWM, Kaiserslautern)

Jens Schulz, Julia Kallrath, Josef Kallrath
(GOR AG)

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Multicriteria Optimization and Decision Support in Industry

Specific aims

Decision problems in practice are often governed by compromising between different conflicting goals: cost and quality, environmental impact and technical complexity or robustness of solutions. There are different strategies to cope with such conflicting objectives. A priori you can set constraints on several of these goals and go for optimization of a single criterion. This approach might cut away excellent and preferable solutions not far away from the chosen set of feasible solutions. Another approach is to compute a set of Pareto solutions and shift decisions on compromises between objectives after computation. This a posteriori approach is often costly and asks for decent decision support techniques in order to explore the variety of efficient solutions.

Fraunhofer ITWM, Kaiserslautern, Germany, will host the topic **Multicritieria Optimization and Decision Support in Industry** and asks for contributions to the questions:

- How to treat optimization problems with different conflicting objectives?
- How are compromises defined and found in practice based on mathematical models?
- What experiences have been made in your company, society with such problems?

The core of this 1.5 day workshop will certainly consist of an attractive schedule of talks. But there will be plenty of time for informal exchange and networking.

In talks of 15+5min, 25+5min or 40+5min duration, experts from practice and research will address problems and solutions.

If you are willing to contribute a talk, please feel free to contact any of the organizers.

Karl-Heinz Küfer (kuefer@itwm.fraunhofer.de)

Jens Schulz (schulz-gor@gmx.net) or Julia Kallrath (julia.kallrath@h-da.de)

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103rd Meeting of the GOR Working Group „Real World Optimization“

Multicriteria Optimization and Decision Support in Industry

Kaiserslautern, November, 21 & 22, 2019

Fraunhofer ITWM Kaiserslautern, Fraunhofer-Platz 1, 67663 Kaiserslautern

Thursday: 09:00 – 15:30 Room: Z03.07/Z03.08

09:00-09:30 *Feel free to join and grab your badge*
09:30-09:45 **Opening and Welcome** (Karl-Heinz Küfer & Jens Schulz)

09:45-10:30 **Karl-Heinz Küfer** (Fraunhofer ITWM)
Introduction to Multi criteria optimization
Multiobjective radiation therapy planning - a game changer

10:30-11:15 ---------- Coffee Break ----------

11:15-11:45 **Sebastian Peitz** (Paderborn university)
Autonomous driving with multiobjective model predictive control

11:45-12:30 **Stefan Ruzika** (TU Kaiserslautern)
Speeding-up Decoding by Optimizing Parity-Check Matrices

12:30-13:30 ---------- Lunch Break in Dining Hall ----------

13:30-14:15 **Serpil Sayin** (Koç University, Turkey)
A Multiobjective Optimization Perspective on Support Vector Machines for Data Classification

14:15-14:45 **Sebastien Lannez** (FICO)
Using Xpress and epsilon constraint methods to solve multiobjective combinatorial optimization problems

14:45-15:15 **Kerstin Dächert** (Fraunhofer ITWM)
Multi-criteria asset allocation

------- Taking a Group Photograph for the OR News and Press ---------

15:30-18:00 ---------- Excursion ----------
Guided tours through the Pfalztheater Kaiserslautern
Willy-Brandt-Platz 4+5; 67657 Kaiserslautern;
https://www.pfalztheater.de

18:30-21:00 **Conference Dinner** in Atrium G/H starts around 6:30pm
- Celebrating the 103rd meeting of our GOR Working Group -

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Friday: 09:00 – 15:00 Room: Z03.07/Z03.08

07:30-08:45 ---------- Breakfast at hotels ----------

09:00-09:45 **Kaisa Miettinen** (University of Jyvaskyla, Finland)
Shape Design in a Ventilation System with a Surrogate-assisted Evolutionary Multiobjective Optimization Algorithm

09:45-10:15 **Volker Maag** (Fraunhofer ITWM)
Green vs. cheap energy supply of buildings: how mathematics can help

10:15-10:45 ---------- Coffee Break ----------

10:45-11:30 **Norbert Asprion** (BASF SE) **and Michael Bortz** (Fraunhofer ITWM)
Single solutions are good but a set of is even better: Decision support in the development of chemical processes

11:30-12:00 **Christopher Bersch** (TUM School of Management)
Strategic planning of new product introductions: Integrated project and variant planning in the automotive industry

12:00-12:30 **Marvin Meck** (TU Darmstadt)
Multi-Criteria Optimization of Pressure Screen Systems in Paper Recycling - Balancing Quality, Yield, Energy Consumption and System Complexity

12:30-13:30 ---------- Lunch Break ----------

13:30-14:00 **Mario Schwerdt** (4flow AG)
Multiobjective transportation problem in empties distribution

14:00-14:30 **David Kik** (TU Braunschweig)
Regional Facility Location and Development Planning considering multiple objectives: Real-world

14:30-15:00 **Erik Diessel** (Fraunhofer ITWM)
Bicriteria Optimization of Risks and Costs in Supply Chains

15:00-15:15 **Final Discussion – End of the Workshop – Coffee Break**

Location: Fraunhofer ITWM Kaiserslautern,
Fraunhofer-Platz 1, 67663 Kaiserslautern

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The following speakers are confirmed:

Norbert Asprion (BASF SE) and Michael Bortz (Fraunhofer ITWM)
Single solutions are good but a set of is even better: Decision support in the development of chemical processes

Christopher Bersch (TUM School of Management)
Strategic planning of new product introductions: Integrated project and variant planning in the automotive industry

Kerstin Dächert (Fraunhofer ITWM)
Multi-criteria asset allocation

Erik Diessel (Fraunhofer ITWM)
Bicriteria Optimization of Risks and Costs in Supply Chains

David Kik (TU Braunschweig)
Regional Facility Location and Development Planning considering multiple objectives: Real-world application

Karl-Heinz Küfer (Fraunhofer ITWM)
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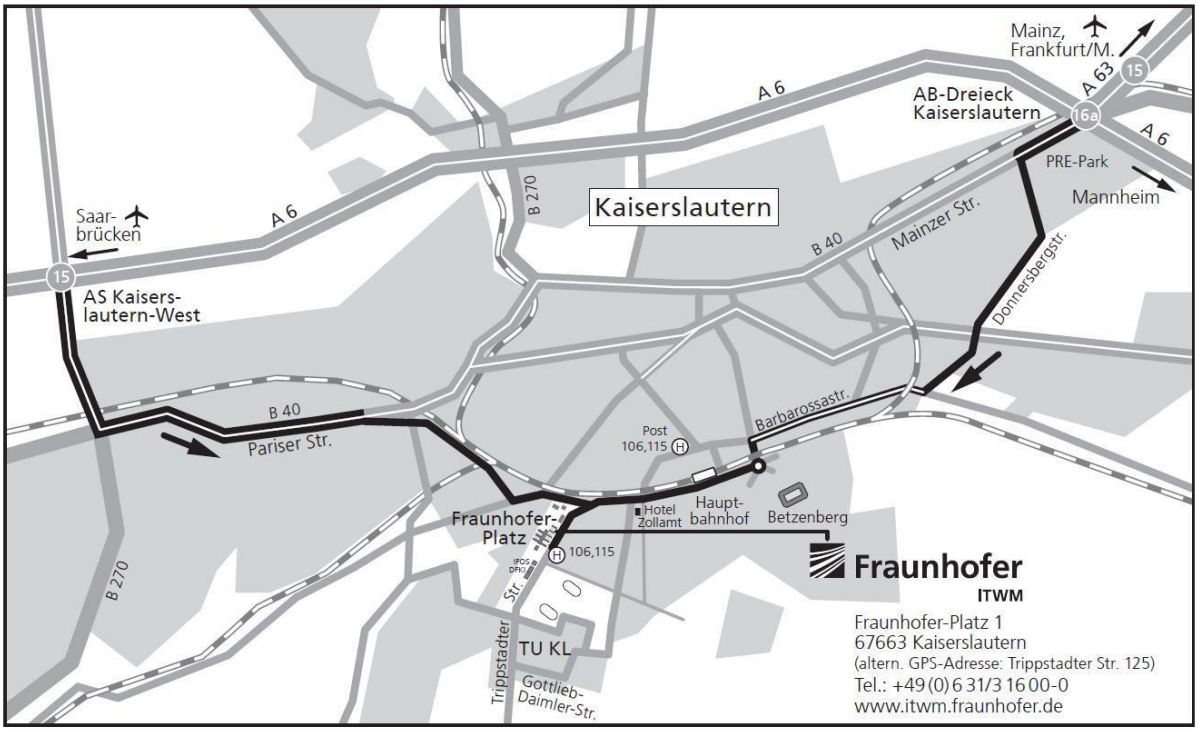
Location

Fraunhofer Institute for Industrial Mathematics ITWM
Fraunhofer-Platz 1
67663 Kaiserslautern
Phone +49 631 31600-0
www.itwm.fraunhofer.de

Directions

www.itwm.fraunhofer.de/en/contact



By Car
Coming from the West on Autobahn A6, take the exit »Kaiserslautern-West« (15), then go towards downtown and follow the signs towards the university. Before you get to the

university, you will reach the Fraunhofer Zentrum a few hundred meters down »Trippstadter Straße«, on the right side.
Coming from the East on Autobahn A6 or A63, take the exit »Autobahndreieck Kaiserslautern« (16a or 15) and follow the sign »Stadtmitte«, then »Universität«. It is best to use the detour behind the train station via Zollamtstraße; at the end of the street, turn onto Trippstadter Straße.
GPS: Fraunhofer-Platz 1, 67663 Kaiserslautern
Alternative GPS: Trippstadter Straße 125, 67663 Kaiserslautern
Parking spaces are available in front of the Fraunhofer ITWM. Enough and free of charge!

By bus

By long distance bus: You can reach Kaiserslautern with a number of long-distance buses. The main bus station is located directly at the central railway station.
From the central railway station you may take a taxi (approx. 2 km), the bus no.115 to »Universität« or the bus from stop »Post« (walking distance from main station: appr. 3 min.) no.106 to »Mölschbach«. Get off the bus at »Fraunhofer-Zentrum«.

By train

The German railway (Deutsche Bahn) offers many connections to Kaiserslautern.
From the central railway station you may take a taxi (approx. 2 km), the bus no.115 to »Universität« or the bus from stop »Post« (walking distance from main station: appr. 3 min.) no.106 to »Mölschbach«. Get off the bus at »Fraunhofer-Zentrum«.

Hotel & Travel

Kaiserslautern is well equipped with nearby hotels and we ask you to arrange your stay in Kaiserslautern by yourselves.

The closest hotels to the conference location and also to the main train station are:

Hotel Zollamt
http://www.hotel-zollamt.de/
(Within ten minutes walking distance to the Fraunhofer ITWM)

Astra Hotel Garni
http://astra-garni-hotel.de/

B&B Hotel Kaiserslautern
https://www.hotelbb.de/de/kaiserslautern

Conference Dinner

Thursday, November 21 2019, 18.30 h

Fraunhofer Institute for Industrial Mathematics ITWM
Atrium G/H
Fraunhofer-Platz 1
67663 Kaiserslautern

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Excursion

Thursday, November 21st 2019, 15.30 h - 18.00 h

Guided tours through the Pfalztheater Kaiserslautern

Take a look behind the scenes. See where and how costumes are sewn and wigs woven, how stage technology works. See the rehearsal rooms of the ensemble, the orchestra and the dance company.

The Pfalztheater Kaiserslautern is the only theatre with a permanent ensemble in the Palatinate and the second largest in the federal state.

Pfalztheater Kaiserslautern
Willy-Brandt-Platz 4+5
67657 Kaiserslautern
https://www.pfalztheater.de

The excursion lasts about 2 hours. The transfer takes place with a shuttle (15.30 h) from the Fraunhofer ITWM (and drives back there). After the guided tour, the first conference day ends with dinner at the Fraunhofer ITWM.

Short CVs

Norbert Asprion
studied mechanical engineering at University of Kaiserslautern, Germany and received his Ph.D. (Supervisor Prof. G. Maurer) in the field of thermodynamics of hydrogen-bonding solutions from Kaiserslautern University in 1996. Since then he is with BASF SE in Ludwigshafen. After several positions in process development and technical marketing, he is currently heading a team responsible for “Chemical Process Modeling” in the department “Digitalization in Research & Development”. His research interest is focused on process modeling, simulation and optimization to support decision making in process development. He is a Senior Principal Scientist at BASF, a member of the EFCE CAPE working party and the CO-LAN management board.

Christopher Bersch
is an external PhD Student at TUM School of Management and employed by a major German automotive company. His research deals with the development of a decision support system for the strategic planning of product introductions in the automotive industry.

Michael Bortz
studied physics in Dortmund and Grenoble. He received his Ph.D. at Dortmund university in 2003. After that, he worked as a PostDoc at Wuppertal, Canberra (Australian National University), Oxford and Kaiserslautern. In 2009 he joined the Fraunhofer ITWM, where he is now hdea of the department for optimization of technical processes. In 2019 he earned his habilitation at Kaiserslautern university. His research interests are in modeling, simulating and optimizing processes in different application domains, including, medical therapy planning, mechanical and chemical engineering.

Kerstin Dächert
holds a PhD in mathematics from the University of Wuppertal. In her thesis she developed a new efficient method to solve multi-objective optimization problems with more than two objectives. She joined Fraunhofer ITWM in 2018 where she was given the possibility to bring her theoretical results into practice. Her work is published in internationally renowned journals such as EJOR, JOGO or COR. Currently, Kerstin serves as an appointed member of the Executive Committee of the International Society on Multiple Criteria Decision Making with around 2800 members worldwide.

Erik Diessel
is a PhD student at Fraunhofer ITWM. His research is focused on models and algorithms for optimizing supply chains with respect to risks. For this task he combines Adjustable Robust Optimization with a multicriteria perspective. He obtained his BSc and MSc in mathematics from University of Technology Kaiserslautern.

David Kik
is a research assistant at the Institute of Automotive Management and Industrial Production (AIP) at the Technische Universität Braunschweig. As part of the research field Energy- and Resource-Efficiency, his research mainly addresses the field of regional facility location and development planning.

Karl-Heinz Küfer
is division director "optimization" at Fraunhofer institute for industrial mathematics at Kaiserslautern. For 20 years his group has been working on decision support systems in

industrial branches like logistics, process engineering, production planning, medical treatment planning and operations research in health care. Interactive multiobjective optimization is the key method that has been proven successful to ease compromising between cost and quality measures well suited to the needs of the decision maker.

Sebastien Lannez
has obtained his PhD from the University of Toulouse working in conjunction with the LAAS/CNRS and the SNCF on large routing and scheduling problems. He then moved to Alstom Grid to develop market and scheduling solvers for various energy utilities and smart grid organisations. He is now working at FICO as Principal Engineer of an Xpress based solution called Decision Optimizer. His work focuses on general optimization software development as well as more specific topics like multi objective optimization or mathematical decomposition.

Volker Maag
is a Senior Scientist at Fraunhofer ITWM, Kaiserslautern, and develops multicriteria optimization tools for the decision support in renewable energy generation and distribution. He studied mathematics at the universities of Constance, York, Toronto and Kaiserslautern, where he was graduated with a diploma in 2006 and with a PhD in 2009.

Marvin Meck
studied mechanical engineering at the Technische Universität Darmstadt and is now working as a research assistant at the universities Chair of Fluid Systems. His field of research involves the optimal algorithm-based synthesis of fluid systems within process industries. Here, exact as well as heuristic methods are used for decision support.

Kaisa Mietinnen
is Professor of Industrial Optimization at the University of Jyvaskyla. Her research interests include theory, methods, applications and software of nonlinear multiobjective optimization including interactive and evolutionary approaches. She heads the Research Group on Industrial Optimization and is the director of the thematic research area called Decision Analytics utilizing Causal Models and Multiobjective Optimization (DEMO, www.jyu.fi/demo). She is a member of the Finnish Academy of Science and Letters, Section of Science and has served as the President of the International Society on Multiple Criteria Decision Making (MCDM). In 2017, she received the Georg Cantor Award of the International Society on MCDM for independent inquiry in developing innovative ideas in the theory and methodology.

Sebastian Peitz
received his Bachelor and Master degree in mechanical engineering from RWTH Aachen University, Germany, in 2011 and 2013, respectively, and his PhD in Applied Mathematics from Paderborn University in 2017. He is currently managing director of the Institute of Industrial Mathematics at Paderborn University, which has as its key objective the implementation of leading-edge mathematical research in industrial processes. His research interests are multi-objective optimization, optimal control and model order reduction of complex systems.

Stefan Ruzika
is professor for mathematics at TU Kaiserslautern. His research comprises mathematical optimization and school mathematics/didactics. He specialized in the area of multicriteria optimization and mainly considers various theoretical research questions in this area. Since 2008, he is also interested in digital communications and explores the connection between (de)coding and mathematical programming.

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Serpil Sayin
is professor of operations and information systems in the College of Administrative Sciences and Economics at Koç University. Her main research expertise lies within the area of multiobjective optimization. She is an active researcher in data mining where she developed optimization-based methodologies for clustering, classification and time series prediction with several applications. She also has an ongoing interest in healthcare management area. She currently serves as the president of the Multiple Criteria Decision Making Section of INFORMS.

Mario Schwerdt
studied mathematics at the Technical University of Berlin, Germany and received his Master of Science in the field of discreet optimization and graph algorithms in 2014. Since 2015 he is with 4flow AG in Berlin, where he contributes to the improvement and development of algorithms to solve complex optimization problems in the field of logistics.

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Abstracts

Speaker: Norbert Asprion and Michael Bortz
Title: Single solutions are good, a set of solutions are better: Decision support in the development of chemical processes

The development of sustainable processes based on different feedstocks is one of the major challenges in chemical process industry [1]. This requires balancing economic interests with environmental and social needs. Therefore, the design and operation of chemical processes are complex tasks with many conflicting objectives and many decision variables that often cannot be chosen completely independently. Considering these tasks as multicriteria optimization problems turned out to be fruitful: The knowledge of the Pareto boundary (or, for discrete alternatives, the Pareto boundaries) allows a transparent comparison of solutions by exploring a large decision horizon.
In this contribution, after a short review of adaptive scalarization schemes, emphasis is put on the impact of its implementation in chemical process industry [2], and on how questions that came up during its industrial use challenged and thereby extended the method to be able to deal with a large class of mixed-integer nonlinear optimization problems.
[1] A. Mitsos, N. Asprion, C.A. Floudas, M. Bortz, M. Baldea, D. Bonvin, A. Caspari, P. Schäfer, Challenges in Process Optimization for New Feedstocks and Energy Sources, Comp. Chem. Eng., 2018, 113, 209-221.
[2] N. Asprion, M. Bortz, Process Modeling, Simulation and Optimization: From Single Solutions to a Multitude of Solutions to Support Decision Making, Chem. Ing. Tech., 90 (11), 1727-1738, 2018

Speaker: Christopher Bersch, Renzo Akkerman and Rainer Kolisch
Title: Strategic planning of new product introductions: Integrated project and variant planning in the automotive industry

Timing the introduction of new vehicles to the market is an important strategic decision in the automotive industry. For several reasons, it is also a complex decision problem. First, due to the use of platforms, shared modules (e.g. engines) create many interactions between different vehicles. Second, new and existing products rely on various shared resources (e.g. development resources or production capacities). Furthermore, different conflicting objectives must be considered.
In this presentation, we summarize a mixed-integer linear programming model for the problem outlined above. It simultaneously decides on the start of production date for vehicle models, product variants and engines as well as on the utilization of engines in the given variants. Besides, we share the concept of a heuristic.
Integrating a multi-criteria approach, our model helps to analyze trade-offs between important managerial objectives related to resource utilization and fleet emission metrics.

Speaker: Kerstin Dächert
Title: "Multicriteria asset allocation"

Strategic asset allocation is a classic task of insurance companies. Once a year they have to decide about their portfolio for the next year. Since Markowitz's famous work in 1952 it is common knowledge to take the two criteria 'maximize return' and 'minimize risk' into account. However, in practice, more criteria come into play as, e.g., maximizing solvency, diversity or other indicators. Moreover, the new portfolio should not deviate too much from the current one, which results in minimizing transaction costs. In a current project with a German insurance company we developed an interactive tool which proposes a set of Pareto-optimal portfolios based on six criteria. In this talk we present how the portfolios are generated, visualized and refined based on exemplary data.

Speaker: Erik Diessel
Title: Bicriteria Optimization of Risks and Costs in Supply Chains
Traditionally, supply chain optimization deals mostly with reducing costs as much as possible. However, this often leads to configurations where failures can have a substantial impact. Instead, better options can be found by integrating risk and cost optimization.
The first part of the talk proposes a model for supply risks based on the framework of Adjustable Robust Optimization. As a risk measure, we consider the worst case of a given set of scenarios of single supplier failures. The model already considers possible mitigations with replacement material provided by other suppliers that can reduce the impact of a particular failure. We show how Pareto-optimal solutions with respect to supply costs and risks are obtained by performing a bicriteria optimization.
Many organizational constraints, for example limits on the number of active suppliers, require integral variables. This creates the challenge of performing a bicriteria optimization of a complex MIP, which is discussed in the second part of the talk. It is not feasible to generate all nondominated points. Hence, we propose an algorithm based on maintaining outer approximations and patches of the true Pareto curve.
By solving specifically designed optimization problems, the approximation comes close to the true Pareto curve in only a few iterations. The talk concludes with results on a realistic supply chain example.

Speaker: David Kik, Matthias G. Wichmann, Thomas S. Spengler
Title: Regional Facility Location and Development Planning considering multiple objectives: A real-world application
Planning new locations is a crucial task, which has a major influence on a company's future orientation and competitiveness. The task is complex, due to three reasons. Firstly, usually multiple qualitative and quantitative objectives are pursued at the same time when assessing potential locations. Secondly, the objectives are often conflictual. Thirdly, the ongoing urbanization faces both companies and municipalities with major challenges in their regional location management. As a result, there is a need for location development, resulting in an active change of location characteristics over time. Therefore, considering dynamics is essential when seeking for suitable locations within regions, as they can have a decisive influence on location decisions. While exogenous dynamics can be found in literature on facility location problems, a systematic location development is, however, missing. Consequently, existing planning approaches neglect the potentials associated with an allocation of company-driven measures for location development. Thus, they may provide inappropriate location decisions. Against this background, in this contribution a suitable model formulation for the Regional Facility Location and Development Planning Problem (RFLDP) is introduced, considering both company-driven as well as municipal location developments over time. Based on a real-world application case, the model is validated in order to demonstrate its practicability. To do so, a planning case of a medium-sized company seeking for a location within the region Berlin/Brandenburg is examined. Herein, the validity of decision recommendations is examined and analyzed with respect to the sensitivity. As a result, we demonstrate that the provided methodological framework is suitable for the regional location and development planning.

Speaker: Karl-Heinz Küfer
Title: Multiobjective radiation therapy planning - a game changer
Radiotherapy planning is an intrinsically multicriteria problem: bring a high dose into the tumor tissue in order to destroy that, and, simultaneously find a good compromise of dosage in healthy tissue around caring particularly about organs at risk.

Fraunhofer ITWM has now been working for approx. 20 years in this application and successfully implemented a new multicriteria planning paradigm in hospitals worldwide together with commercial partners. Basis for this success is a patented interactive navigation tool of the planning horizon, staged in 1-2-3 dimensional perspectives addressing 1D gross volume objectives, 2D dose volume objectives and finally 3D dose distribution as such.

Speaker: Sebastien Lannez
Title: Using Xpress and epsilon constraint methods to solve multiobjective combinatorial optimization problems
The two functionalities we will present during this talk allow the user to explore the objective function value space and discover the relationships between various objectives by solving multiple objective combinatorial optimization problems. The first approach is specific to Xpress Decision Optimizer. It allows the user to specify the objectives or constraints to explore, defines ranges and the exploration step size and lets the software search for optimal solutions in the partitioned feasible space. This approach can be seen as a simplified version of the epsilon constraint method described by Haimes, Ladson and Wismer in [1] in which the epsilons are uniformly sampled over a distribution defined by the end user. The optimization problem is solved for every partition and the optimal solutions are displayed on a two-dimensional graph for which the two axes are taken from the set of objectives. The second approach has been developed as an Xpress Mosel package and applies a more dynamic algorithm based on an implicit enumeration of all possible epsilon values as proposed by Kirlik and Sayin in [2]. This latter approach ensures that all non-dominated solutions will be found but is computationally more demanding.
[1] Haimes, YY, Ladson, LS & Wismer DA, "Bicriterion formulation of problems of integrated system identification and system optimization." IEEE Transactions on Systems Man and Cybernetics, vol. 3, pp. 296, 1971
[2] Kirlik G, Sayin S, "A New Algorithm for Generating All Non-dominated Solutions for Multiobjective Discrete Optimization Problems." European Journal of Operational Research, Vol. 232, pp. 479—488, 2014

Speaker: Volker Maag
Titel: Green vs. cheap energy supply of buildings: how mathematics can help
The energy supply of buildings is an important, but sometimes underestimated aspect in the fight against climate change. One motivation for choosing a "greener" solution can be long-term savings in operating costs. In the talk we describe an approach to make these costs, including associated uncertainties, in the area of office buildings transparent through a decision support system. In the underlying optimization problem, various goals such as investment and operating costs, comfort and emissions of carbon dioxide are considered. The degrees of freedom consist in the choice of the components of the energy supply such as generators, storages or external suppliers as well as the distribution system. Essential challenges are a sufficiently precise characterization of the energy demand of a building as well as its coverage by the operation and the interaction of the components. We briefly describe the statistical methods we have applied to the former and the flexibly extensible modelling we have developed for the latter. Mastering these challenges enables us not only to calculate the operating costs, but also to compare and evaluate different supply concepts and to evaluate the effects of changes in inflation rates, subsidies or the like. We will demonstrate these using a few examples.

Speaker: Marvin Meck

Title: Multi-Criteria Optimization of Pressure Screen Systems in Paper Recycling - Balancing Quality, Yield, Energy Consumption and System Complexity

The paper industry is the industry branch with the highest recycling rates. In Germany, the amount of recycled fibers in newly produced paper has since 1990 steadily been increasing from approximately 48 to 75 % in 2018 [3]. In contrast, the use of secondary products in the production of steel, aluminum, copper and other non-ferrous metals is generally only around 40 to 50 [1,2].

Using recycled paper instead of fresh fibers results in lower resource and energy consumption. However, adhesive contaminants in recycled paper negatively impact quality. Therefore, pre-processing is required to remove as many contaminants as possible. The paper is first disintegrated, resulting in a suspension containing water, fibers and contaminants. This suspension passes several stages of separation. The fine screening system, consisting of an array of pressure screens, is used to separate adhesive contaminants from fibers. Pressure screens can be interconnected in several ways, and suitable screen designs as well as operational parameters have to be selected. Here, two conflicting goals arise: The fiber yield should be as high as possible while at the same time the separation of contaminants should be as high as possible in order to achieve high quality. The passage ratios of fibers and contaminants are the decisive parameter. They are strongly influenced by the design of the screen and are dependent on another. In order to yield high paper quality low passage ratios of the contaminants need to be achieved. This however, leads to an increase in fiber losses and therefore to an increase in production costs.

In industrial settings, the planning and operation of such screening systems is still based on rules of thumb and expert knowledge. In an attempt to bridge the gap between mathematical expert knowledge and its application in real world engineering settings, we present an optimization approach based on a model by Fügenschuh et al. [4]. Besides maximizing quality and fiber yield, we also consider the minimization of resource-consumption and complexity of the system. To transfer our results to industrial settings, we present a software tool with a problem-specific graphical user interface (GUI). It allows for a simple formulation and an easy adaptation of the optimization model to individual constraints such as existing infrastructure, as well as for a clear graphical representation of the results of the multi-criteria optimization.

[1] Anteil sekundärer Rohstoffe an der Produktion von Kupfer, Aluminium und Rohstahl in Deutschland im Jahr 2017. In Statista – The Statistics Portal. Access on 8th November 2019 from https://de.statista.com/statistik/daten/studie/259779/umfrage/recyclinganteil-bei-der-produktion-ausgewaehlter-metalle-in-deutschland/. Data collected by the International Copper Study Group (ICSG), the German Steel Federation (WV Stahl) and the German Steel Recycling and Disposal Companies (BDSV), data prepared by the German Institute for Geosciences and Natural Resources (BGR).

[2] Recyclinganteil in der NE-Metallindustrie in Deutschland in den Jahren 2009 bis 2016. In Statista – The Statistics Portal. Access on 8th November 2019 from https://de.statista.com/statistik/daten/studie/238100/umfrage/recyclinganteil-in-der-ne-metallindustrie-in-deutschland/. Data by the Federal Statistical Office of Germany (StBA), data prepared by WirtschaftsVereinigung Metalle e.V. (WVM)

[3] Verwertung und Entsorgung ausgewählter Abfallarten. Altpapier. In Website of the German Environment Agency. Access on 8th November 2019 from https://www.umweltbundesamt.de/daten/ressourcen-abfall/verwertung-entsorgung-ausgewaehlter-abfallarten/altpapier#textpart-3. Data collected and prepared by Verband Deutscher Papierfabriken e. V. (VDP)

[4] Fügenschuh, A., Hayn, C., Michaels, D.: Mixed-integer linear methods for layout optimization of screening systems in recovered paper production. Optimization and Engineering 15(2), 533--573 (2014)

Speaker: Kaisa Mietinnen
Titel: Shape Design in a Ventilation System with a Surrogate-assisted Evolutionary Multiobjective Optimization Algorithm
We consider a shape design optimization problem of an air intake ventilation system in a tractor cabin. We solve the simulation-based multiobjective optimization problem with a preference-based surrogate-assisted evolutionary algorithm. We are motivated by practical applicability and pay attention to two main practical challenges: 1) meaningful formulation of the optimization problem reflecting the needs of a decision maker and 2) finding a desirable solution based on decision maker's preferences when solving a problem with computationally expensive function evaluations. For the first challenge, we model a component in the air intake ventilation system with commercial simulation tools. The problem to be solved involves time consuming computational fluid dynamics simulations. Therefore, for the second challenge, we extend a Kriging-assisted evolutionary algorithm K-RVEA to incorporate a decision maker's preferences. The numerical results indicate computational efficiency and ability to reflect the decision maker's preferences well. Actually, two of the solutions obtained dominate the baseline design (the design provided by the decision maker before the optimization process). The decision maker was satisfied with the results and eventually selected one as the final solution.

Speaker: Sebastian Peitz
Titel: Autonomous driving with multiobjective model predictive control
In almost all complex technical systems, several competing objectives are of similar interest. A key example is autonomous driving, where the vehicle should reach a desired location as safely, fast and energy efficient as possible. Model predictive control (MPC) is a prominent approach to construct a feedback control loop for dynamical systems such as autonomous vehicles. However, due to the real-time constraints, considering multiple objectives is rarely feasible. In order to overcome this issue, an extension to the well-known explicit MPC to multiple objectives is presented. In the offline phase, a library of Pareto optimal solutions is constructed from which a valid compromise solution is selected in the online phase according to a decision maker's preference. To reduce the number of problems that need to be solved in the offline phase, symmetries in the dynamical system and the corresponding multiobjective optimal control problem are exploited. The results are verified using two different examples from autonomous driving.

Speaker: Stefan Ruzika
Title: Speeding-up Decoding by Optimizing Parity-Check Matrices
In this talk, we consider channel coding and, in particular, decoding of received codewords which were sent over a noisy channel. Maximum-likelihood decoding is a desirable and powerful tool in digital communications to obtain the optimal performance of a channel code. Simulating the decoding performance is difficult and its complexity grows exponentially with the block-length of the code. In this paper, we present methods for speeding up the decoding. This is achieved by transforming the binary parity-check matrix into a matrix which has the same kernel but fewer one-entries. We present a mathematical programming formulation for this problem and algorithms for optimizing parity-check matrices. Moreover, we report about the actual speed-up obtained for various code classes.

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Speaker: Serpil Sayin
Title: A Multiobjective Optimization Perspective on Support Vector Machines for Data Classification

Data classification problem is encountered in diverse application domains such as healthcare (e.g. disease diagnosis), production (e.g. failure and reliability prediction), marketing (e.g. promotion response prediction) among others. Support Vector Machines (SVMs) present an optimization-based approach to the classification problem. The original SVM formulation seeks to minimize generalization and empirical errors and is indeed a bicriteria one. However, the formulation is expressed by a single scalarized objective function that uses a balancing parameter. In this talk, we take a traditional multiobjective optimization approach and find all extreme nondominated SVM classifiers using a biobjective formulation. We show that the additional computational cost of enumerating all classifiers may not be too high when objectives are linear due to a simple mechanism that is in motivated by sensitivity analysis in linear programming. Experiments on real data in comparison with multiple runs of an SVM model in order to tune the balancing parameter show that although the standard tuning approach is good at achieving comparable results for the most part, its performance may be less than satisfactory on some instances. Moreover, re-running an SVM model multiple times with different values of the balancing parameter is always more expensive than our comprehensive approach. We also investigate a triobjective SVM formulation where the empirical errors for the two distinct classes are handled separately. This is useful especially on imbalanced data sets. As the three objective optimization problem is more difficult to solve, we explore different sampling strategies on nondominated classifiers. We observe that these sampling strategies differ in terms of their classification accuracy and computational cost on real imbalanced data sets. We conclude by identifying future research directions.

Speaker: Mario Schwerdt
Title: Multiobjective transportation problem in empties distribution

In production networks, the focus usually lies on the goods that are transported from the supplier to the production plants. However, these goods are usually packed in containers (e.g. wire container, euro pallet) and these empty containers need to get back to the suppliers.
The big question is now: From which plant does a supplier get its empties?

To reduce the operational effort in answering this question for each supplier when it is short on empties, one approach is to determine one (or multiple) plant(s) to order the empties from. Such a plant is then called main provider for the supplier.

In this talk, we will discuss the problem of finding main providers. Specifically, we deal with the question how to create a mathematical model from user expectations in the form of:

- The transportation costs have to be minimized
- Not too many suppliers may have multiple main providers

We will then discuss ideas how to solve this problem in a combinatorial way on big data sets.