International Conference on Mathematical and Algorithmic Optimization – SIGOPT 2025
Ulf Lorenz, Siegen

The SIGOPT 2025 conference took place from March 4 to 6, 2025, at the University of Siegen in the city of Siegen. The Special Interest Group on Optimization (SIGOPT) was founded over 30 years ago, and this was its 6th meeting after Lambrecht (2011), Trier (2016), Irsee (2018), Dortmund (2020), and Cottbus (2023). The presentations were selected by a program committee consisting of Armin Fügenschuh, Alfred Müller, Ulf Lorenz, Erwin Pesch, and Rob van Stee. The organizing team was further supported by additional members of Ulf Lorenz's chair, including Tanja Franke, Florian Breda, Julian Mrochen, Ralf Dreier, Martin Gerhards, and several students.

The program included five invited talks and 46 contributed presentations, making for a dense schedule; the three days started at 8:30 AM, i.e. early for many participants. Similar to previous SIGOPT conferences, this year saw 77 attendees from various nations. The evening before the conference, about half of the participants gathered for a small reception in the foyer of the lecture hall building. Drinks and snacks at standing tables provided an opportunity for initial networking. Small wooden puzzles and the game "*EinStein würfelt nicht"*, developed by our Ingo (Althöfer), motivated interaction.

On Tuesday, the conference officially began. After a brief opening speech by Ulf Lorenz, welcoming the participants and providing practical details about the university facilities and the cafeteria,

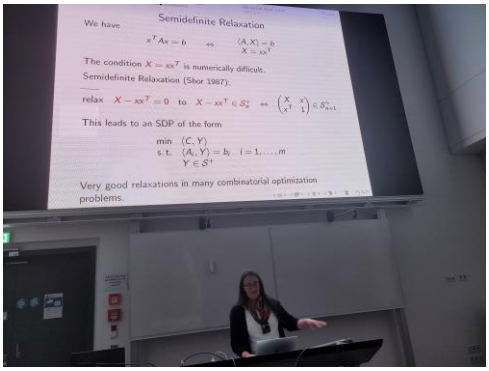
SIGOPT 2025 kicked off with a plenary lecture by Danny Segev from Tel Aviv. He presented new insights into the Joint Replenishment Problem (JRP), a classical issue in inventory and stock optimization. JRP deals with the optimal coordination of replenishments for multiple products to minimize storage and ordering costs. While the problem is trivial for a single item, efficient solution algorithms for multiple items have remained an open question for decades.

Plen. talk by Danny Segev

To analyze the problem, Danny Segev first introduced classical results, particularly the most well-known models for determining optimal order cycles. He then discussed recent approaches, including approximation algorithms and convex relaxations of JRP. Since the early 2000s, approximation guarantees slightly above one have been established using randomized rounding methods. Since 2018, it has been known that an FPTAS does not exist, but as a new result, Danny Segev presented an EPTAS, closing the complexity gap.

The main conference sessions took place in two parallel streams in the beautiful lecture halls of the US-C building at the University of Siegen. These sessions were framed by plenary lectures. Consequently, later on the first day, a second invited talk was given by Mirjam Dür from the University of Augsburg. She spoke about recent developments in conic optimization, a class of optimization problems generalizing linear and semidefinite programming. Conic optimization plays a

key role in areas such as machine learning, combinatorial optimization, and financial mathematics. Her talk particularly focused on optimization over copositive cones, a powerful but computationally demanding technique with connections to graph theory and robust optimization. Copositive optimization serves as a unifying framework for combinatorial optimization, non-convex quadratic, and polynomial programming. It offers new insights into these problems and provides strong general bounds through approximation hierarchies for copositive cones. Additionally, it opens new perspectives for combinatorial optimization on infinitely large graphs.



Plenary talk by Mirjam Dür

The third central talk was given by Anita Schöbel. She is not only a professor at RPTU Kaiserslautern-Landau but also the director of the Fraunhofer Institute for Industrial Mathematics (ITWM). ITWM employs 550 researchers working on industrial research projects in applied mathematics. At SIGOPT 2025, she presented new approaches for sustainable public transport. Her talk focused on making public transportation more attractive, sustainable, and economically viable. She examined not only route, schedule, and vehicle allocation optimization but also innovative measures to reduce emissions and energy consumption.

Plenary talk by Anita Schöbel

To address these challenges, Schöbel applied various mathematical optimization techniques. One key aspect was the skip-stop strategy, where certain stops are skipped to save energy and reduce travel time. She also introduced a method for using regenerative energy, where braking energy from arriving trains is efficiently transferred to departing trains. Additionally, she touched on reducing tire wear, as tire abrasion significantly contributes to global microplastic emissions.

Based on these subproblems, she presented a holistic planning approach for public transport that integrates multiple transport modes and optimizes them considering travel times, budget constraints, and CO_2 emissions.

Her results demonstrated that mathematical optimization can play a crucial role in urban mobility sustainability. Particularly, integrating infrastructure planning, energy savings, and passenger behavior modeling enables more efficient and attractive public transport solutions. The presented concepts have significant potential for future mobility planning, especially regarding climate protection and urban traffic management.

Already at midday on the same day, Nicole Bäuerle (Karlsruhe Institute of Technology, KIT) gave a plenary lecture on optimality criteria for dynamic investment strategies and their mathematical relationships. The aim was to analyze different evaluation methods for investment decisions, especially considering uncertainties and risk management. Different approaches were considered, including risk-sensitive models, mean-variance criteria and robust optimization methods.

Plen. talk by Nicole Bäuerle

To model these investment problems mathematically, Markov decision processes (MDPs) and Bellman equations, which calculate optimal strategies for dynamic markets, were used as usual. It was shown how this can be used to solve multi-stage risk-sensitive problems, i.e. to calculate optimal policies. Particular challenges arose due to time inconsistency, which occurs above all in the mean-variance approach: a strategy once selected as optimal may be suboptimal at a later point in time. Risk-sensitive optimization, on the other hand, allows greater consideration of uncertainties by evaluating investments with exponential utility functions. In addition, robust optimization methods were presented that explicitly take model uncertainties into account in order to enable more stable investment decisions in the long term.

Wednesday flew by and was supplemented and given further highlights by a city tour and a conference dinner.

During the city tour, participants interested in culture were able to learn details about the city of Siegen and the Siegerland region, which has a long tradition of steel production and processing. However, participants who were perhaps less interested in culture were also able to clear their heads and stretch their legs in the beautiful weather.

The Nikolai Church with its little crown concluded the tour. The history of the church dates back to the 13th century and is still the only church on this side of the Alps with a hexagonal floor plan, also known as a hall hexagon. The Nikolaikirche became a Protestant church in 1530. Since the Reformation, it has been the main parish church of the city of Siegen. With its golden crown at the top, the symbol of the town and a gift from Prince Johann Moritz von Nassau to the citizens on the occasion of his elevation to the rank of prince in 1652, it is the only Christian church in Europe, if not the world, that bears neither a cross nor a cockerel.

The subsequent conference dinner then took place in the Haus der Siegerländer Wirtschaft, a building belonging to the employers' association where culinary celebrations are often held, whether by industry, the University of Siegen or privately, e.g. at weddings.

On the last day, there was another plenary lecture highlight. Marc Pfetsch (TU Darmstadt) gave a lecture entitled “Combinatorial Aspects of Physical Networks”. He dealt with the mathematical modelling and optimization of physical networks, especially those in which flows such as water, gas or electricity flow through pipes. The central concept was so-called potential-based flows, which describe these physical processes using mathematical equations. Particular attention was paid to the interaction between the combinatorial structure of these networks and the underlying non-linear optimization problems.

Plenary talk by Marc Pfetsch

Marc Pfetsch showed how the property of potential-based flows to always be acyclic can be used to sharpen mixed integer optimization formulations and derive combinatorial models.

Using new optimization methods, it was possible to speed up calculations for real gas networks by a factor of 5 to 7. In the second part of his presentation, he addressed the problem of reconstructing network structures when only the data for the inputs and outputs of the network are known. Another focus was on topology optimization, i.e. the question of how a network can be designed efficiently.

Overall, the lecture showed that potential-based flows form a powerful basis for analyzing physical networks. The combination of non-linear and discrete optimization opens up new avenues for efficient network planning, for example for future hydrogen transport networks.

If I, as the author of this report, am allowed a small comment at the end, I would say that the city of Siegen, the university and even the weather have shown their best side during these days and I am really very pleased that we were able to organize this conference here in Siegen in March 2025. I hope SIGOPT and the city of Siegen will remain in positive memory of the participants for a long time.

Group foto: Participants of the SIGOPT 2025 in Siegen