

IFORS

International Federation of Operational Research Societies

NEWS

FROM THE PRESIDENT

Janny Leung <jannyleung@um.edu.mo>

I recently read an article predicting the highest-paying jobs in 2040. The futurists' view is that most of the professions we know today may be obsolete by that time. With the rapid advancement of Artificial Intelligence, it is predicted that in twenty years' time, machines will be better than humans in translating languages, driving cars, writing essays or even performing surgeries! Some jobs may not exist at all in the future; for example, there may not be any human taxi-drivers or deliverymen, no human shop-assistants or human restaurant-waiters. The workforce in accountancy and the legal profession may be drastically reduced, because much of the document processing, fact-finding and data-checking will be automated.



According to the futurists, the hottest jobs in 2040 will be Data Scientists, Analytics Experts, Metaverse Architects and Cybersecurity Engineers. The future world is a digital one, where our lives are supported (and hopefully not ruled) by massive amounts of data from a myriad of sources. How to extract useful information and put them to good use without abuse is the responsibility of these new professions. I find this reassuring and heartening. The essential skills needed for these new job categories are exactly what the Operational Research training provides! OR scientists understand the importance of comprehensive information-gathering to identify the key issues and objectives of the situation at hand. OR scientists possess the knowledge and skills to develop appropriate models and algorithms to address the problem. Good OR scientists always evaluate the impact of the changes on all stakeholders.

The envisioned future world is one where humans and machines work together. This is good news for us as humans, machines will relieve us from routine repetitive tasks to free us to work on the more creative (and enjoyable) aspects of work. Even the most optimistic futurists think that AI may still not be as good as people at creative problem-solving, empathetic reasoning, philosophical debate or collaborative dynamics in the foreseeable future. Therefore, what makes us human – creativity, empathy, problem-solving ability – are going to be more important than ever. As the rate of technological change increases, resilience and adaptability will be vital. Moreover, humans still out-perform machines in creative original thinking that draws from the interaction of different disciplines.

I believe this puts Operational Research at the leading edge of this brave new world. Our field was born from the necessity of taking a multi-disciplinary approach to address critical problems in a world crisis. As technologies develop, our OR knowledge base has evolved, from predictive models (when data was scarce) to fast complex algorithms (as computational power accelerated) to integrative adaptive approaches (for big data analytics). In 20 years' time, our world may still be facing the same challenges – food and clean water, pollution-free environment, access to education – that plague us today. However, I am optimistic that Operational Research as a field will keep evolving and advancing to remain relevant and effective in addressing key concerns of society. 🌍

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FROM THE EDITOR IN CHIEF

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Welcome to the December issue of the IFORS Newsletter!

We are closing one more year of intense activity in the OR global community, and in this issue, we offer a sample of methodologies and applications covering several areas and geographical origins. Moreover, the Conferences' section shows a lively community which exchanges knowledge and experiences, a key factor to keep the strength of the discipline.

The December issue of the IFORS Newsletter includes content related to its regular sections. In the *OR and Development* section, colleagues from several institutions of Argentina report the application of data science and simulation for supporting the management of the COVID-19. The study highlights the challenges of modeling under a scenario of variable data quality coming from different administrative divisions. The tools developed cover dimensions of description, analysis and planning, and they provide a real-time online platform for processing, displaying and analyzing data, which was adopted by public authorities. In the *Tutorial section*, a colleague from University of Tours, France, presents the main concepts of matheuristics, a specific type of metaheuristics which relies strongly on the mathematical programming formulation of the problem. A simple and effective way of performing a local search aided by an exact formulation is explained. It is argued that the efficiency of this procedure may improve as mathematical programming software evolves over time. According to the author, the current small set of existing application areas of matheuristics is expected to grow in the next decade. In the *OR Impact* section, members of the Ingentus company and the Vienna Red Cross, Austria, report an application of resource allocation and planning methodologies and tools at the regional Red Cross branch. The authors created software which improved the automation of the process which allocates staff to tasks, including time-related restrictions coming from legal regulations. The system provides decision support through a web application which contains a metaheuristic-based problem solver and enables to visualize and edit results. The tools generated by the project reported are used in humanitarian logistic operations, including homeless assistance and rescue services.

Moreover, the *Conferences* section reports 25 events worldwide on OR and related disciplines, while the Book Review section reports on the volume "Fundamentals of Convex Analysis and Optimization – A Supremum Function Approach".

We thank all authors and section editors for their contributions, and we hope you enjoy the reading! 🌍



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Ballot Deadline: March 31, 2024

Section editor: **Mario Guajardo** <mario.guajardo@nhh.no>

Data Science and Simulation Tools Developed at Public Universities for Supporting Argentina's COVID-19 Response Decision-Making



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Note from the Section Editor: The following article is an extended summary of the work by an Argentinean team that supported the decisions of public authorities during the COVID-19 pandemic. As announced during the conference dinner in the 23rd IFORS triennial conference in Santiago, this work was selected as the runner-up of the IFORS Prize for OR in Development 2023, receiving a grand prize of US\$2,000.

Introduction

As the spread of the coronavirus (COVID-19) hit Argentina in early March 2020, the national government rushed to adopt the necessary measures for halting the propagation of the virus. During the early weeks of the epidemic, the country's health administration systems came under a degree of pressure never before experienced. The impact was also felt by their information management systems due to the sudden need for data systems capable of monitoring the state and progress of the pandemic across the entire country and supporting evidence-based planning relying on future scenario projections.

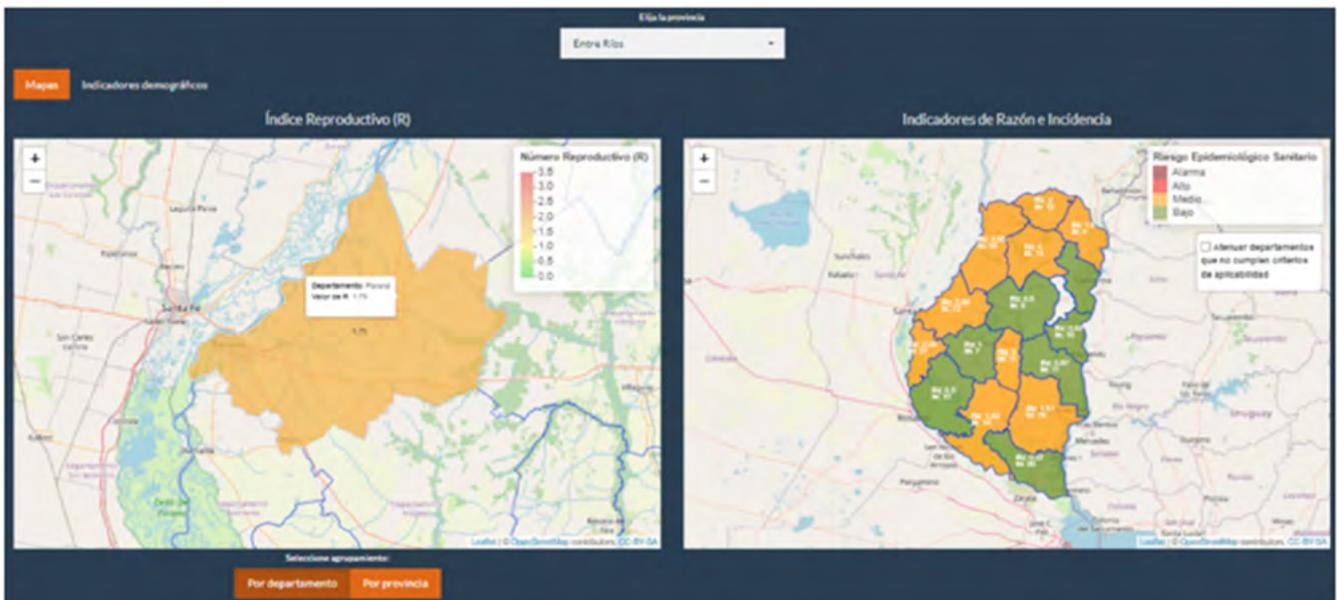
Slowly but surely, new sources of data became available from national government sources, and a database with daily updating was created that included such information as newly detected infections, hospitalizations and deaths. However, this data set presented anomalies in the dates of records as a result of various factors, including late reporting of symptoms, delays in testing, and sluggish processing and data entry of new cases. This situation directly impacted any attempt for modeling, simulating

or predicting the evolution of the disease based on official data sets as the primary source of information.

With no option to wait for improvements in the data sources, and working in a context where any delays in decisions could cost lives, it was essential to adopt modeling techniques robust to inaccuracies in the data that was available. In the face of this combination of circumstances, it was clear that teams of experts in science and technology would be needed with the necessary know-how in computer science, operations research and data science to provide governments at all levels and society in general with more and better tools for combating the epidemic. This was especially the case in a country such as Argentina whose economic infrastructure is in the process of development, exacerbating the difficulties involved in dealing with a global emergency on an unprecedented scale.

Methodological approach

An automated system was developed that would enable the incorporation of multiple data sources, data quality control, interactive multi-dimensional data display, statistical analysis and the generation of computer-simulated projections in real time as new information became available. The system also had to take into account the geographic divisions of responsibility of the country's public health authorities, providing information granularity not only at the national, provincial and municipal levels but also for health districts and urban areas.



▲ Figure 1: Georeferencing of the reproduction number R, ratio and incidence indicators.

For each such geographic area, the system had to provide various metrics for the evolution over time of different objectives, as outlined below.

- For description: Evolution of cases, cases as a proportion of the area population, breakdowns of cases by age bracket and sex, etc. The same was required for the vaccination data.

- For analysis: Intensity of case evolution (the R reproduction number), data entry time, alert level traffic light, vaccination campaign impact analysis, etc.

- For planning: Projection of future case evolution under various assumptions, design of policies based on “what if” simulations for different possible interventions (e.g., time- or location-specific restrictions), etc.

Each day, algorithms were run to determine the availability of public data set updates, analyze their quality and consistency and persist them to a data base. Meanwhile, an algorithm pipeline processed new information and updated all statistical indicators, making them available for analysis.

One particular calculation stage combined optimization algorithms with epidemic simulation models to estimate the R

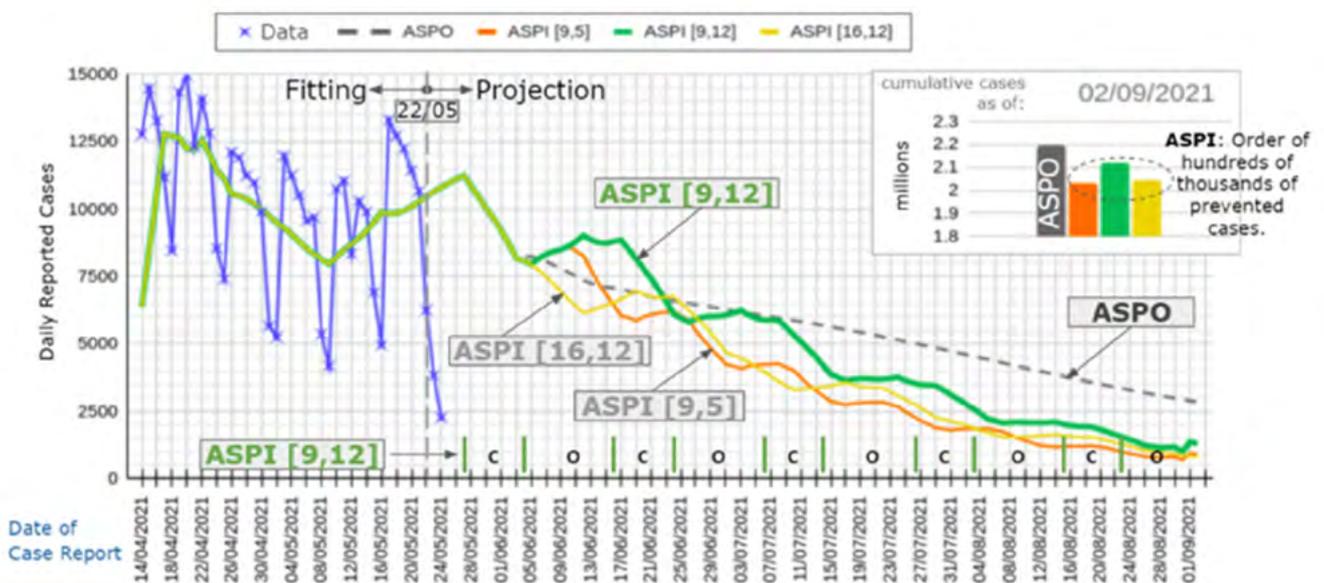
number for different time intervals and geographical areas. Artificial intelligence algorithms were used to project demand levels for intensive care units.

A key characteristic of the software developed by the project was its capacity to flexibly incorporate into the automated process new data analysis modules that were needed as the health emergency evolved. This strategy proved to be successful given that the information provided by the platform was the outcome of a spontaneous evolution in the requirements and demands of multiple sectors (public officials, journalists, academics, etc.) that the software was able to satisfy both in time and content.

Results

The main result of the project was a real-time online platform for processing, displaying and analyzing data relating to COVID-19 in Argentina, as well as generating analyses of the impact of the country’s public policies on the epidemic and simulating future intervention strategies.

The platform became accessible from within and outside the country to the general public as well as public officials, journalists and specialists involved in developing data-based models.



▲ Figure 2: Illustrative ASPI scenarios for the Buenos Aires Metropolitan Area with closure compliance level of 30%.

Information generated by the platform was used to provide support at advisory meetings with a wide variety of public officials from the different provinces and cities of the country. As an illustration, Figure 1 provides a graphical view on the estimate of the R number and other indicators for the Entre Ríos province.

Notably, the platform's data analysis and simulation experiments enabled the development of an epidemic management response denoted ASPI (in English, planned selective intermittent lockdowns) for bringing down case numbers through intermittent lockdowns. This ASPI policy was found to be more effective than a comprehensive lockdown response (known as ASPO, the Spanish abbreviation for mandatory preventive lockdown). A numerical example for the Buenos Aires Metropolitan Area in May 2021 is shown in Figure 2. Here, the results in daily case numbers for different ASPI opening and closure cycle scenarios are illustrated. Each cycle is denoted by a number pair [C,O] representing the lengths in days of the Closure (C) and the Opening (O), respectively. In particular, the graph shows three different socially viable cycles, all assuming a compliance level 30% during the closures. Evident from Figure 2 is that all three ASPI scenarios obtain better results in the medium and long term than a prolonged ASPO-type closure, with compliance levels for the latter that decline over time.

Concluding remarks

This work gained widespread recognition in various formats, including adoption by public authorities. Close relationships were developed with the government of Buenos Aires Province through its Ministry of Health. Analyses and reports were drawn up for the Ministry on the situation in the province, the country's most important region containing almost 40% of its population. An example of the work for the Ministry was an observational study quantifying the impact on the probability of death due to COVID-19 of the vaccination campaigns conducted in 2021 in Buenos Aires Province. Death probability was modeled and vaccine effectiveness curves and death probability reduction

rates were then derived, broken down by age, sex, municipality of residence and vaccine scheme administered. Among the conclusions of the study were that the vaccination campaign in the province had a highly positive impact in preventing COVID-19 deaths in the population of confirmed cases.

Finally, in addition to a number of media articles about the project, multiple academic seminars were held at various state universities explaining the mathematical models that were developed and the software's architecture. Public lectures were held, attended by prominent figures in health, science and technology, human rights and various business and trade organizations. A number of scientific papers have also been published on the various models developed by this project, see e.g. Bergonzi et al. (2020), Arrar et al. (2021), and Lanzarotti et al. (2021).

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OR TUTORIAL

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Matheuristics: how to easily solve optimization problems

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Optimization problems are not a myth, and not even a legend: they frequently appear in everyday's life. You want to order something on the web? Your delivery will have to be optimized. Your company produces goods? To improve the efficiency of your production system, you need to optimize it. You work in a hospital and you have to organize the planning of surgeries? This also requires to solve an optimization problem. Faced with such a problem, some people may just try to find a solution by hand: this does not lead to a solution of the best quality, but it can do the job. However, other people decide to go further and turn to computer science and mathematics to build algorithms to solve their problem. The scientific literature on algorithms for optimization problems resembles to a vast jungle in which only scientists seem to be able to dive in. Combinatorial optimization, mathematical programming, operations research, ... all these research fields propose their own set of techniques to solve optimization problems.

From this big bazaar, let's pick up a specific class of algorithms that have the specificity of being efficient and relatively easy to implement. They are called matheuristics and are sometimes confused with metaheuristics. The latter are much more general and, obviously, include matheuristics. Following operations research field, they are heuristic algorithms for hard optimization problems: consequently, they should be fast and provide a solution as close as possible to an optimal one. To define matheuristics we quote ([1, 3, 5]):

"Matheuristic is the hybridization of mathematical programming with metaheuristics. [...] Matheuristic is not a rigid paradigm but rather a concept framework for the design of mathematically sound heuristics."

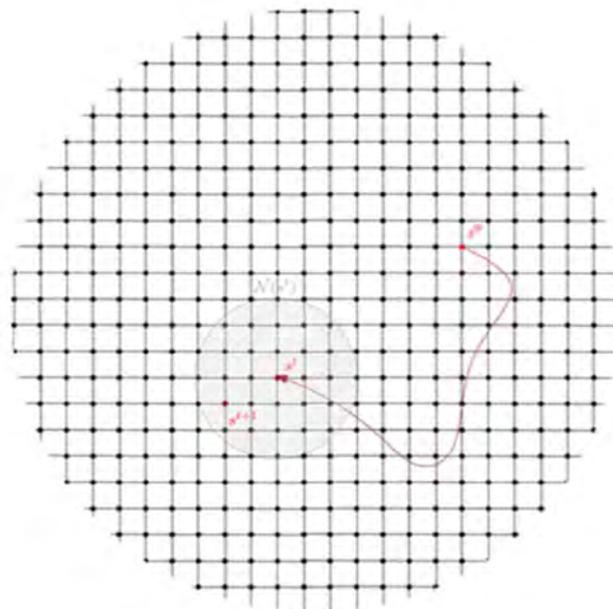


So, matheuristics heavily rely on mathematical programming and that is their main advantage: it can be expected that a matheuristic becomes more effective over time, and without any change, as existing black-box solvers for mathematical programming are continuously improved ([2]). From a literature review we can evince that early papers on matheuristics have been published between 2005 and 2010, but most of them date back after 2015. A quick search on any bibliographical search engine shows that very few research papers have been published on matheuristics by comparison to other metaheuristics like, e.g., Tabu search. And most of them are dedicated to the solution of transportation and/or scheduling problems. Matheuristics should definitely become much more popular in the next decade.

Now that the ice is broken, let's have a closer look on how matheuristics work. Suppose you are at home and you live in a huge residential area. You have a day off and you decide to do a treasure hunt: what you want to do is to collect as much gold as possible in that residential area. To help you, suppose you have a very smartphone that is capable of telling you in a range of half a mile who is the neighbour having the most gold. So, from your home your smartphone tells you where to go: you steal your neighbour and ask where to go next until no more gold can be found. This images the principle of matheuristics.

Faced with an optimization problem and to design such a heuristic, the researcher or the engineer has first to design a mathematical programming (MP) formulation. This is probably the most technical part, the remainder being layers of algorithmics on top of the MP formulation. We know that for most of the optimization problems, asking a black-box solver to directly solve this MP formulation is unrealistic because it leads to *exponential computational times*. A matheuristic makes a particular use of this formulation. Starting from an initial solution, it iteratively improves the current solution by exploring its *neighbourhood*. Let's look at figure 1 and suppose the grid represents the space of solutions: the point s^0 represents the starting solution and the point s^t represents the current solution at the t -th iteration. To compute the solution s^{t+1} of the next iteration, the matheuristic explores the neighbourhood $N(s^t)$ (the grey circle in the figure). It is asked that s^{t+1} improves upon s^t or else the algorithm stops. How is this exploration done? Simply by solving the MP formulation when applied to the neighbourhood (let's just skip the technical details). In practice, for the scientist, it is a really easy task to setup such an algorithm when the MP formulation is defined.

For sure the above general principle can be refined with extra



▲ Figure 1: An iteration of matheuristic

techniques to lead to even more efficient matheuristics. But, we should just keep in mind that implementing a basic matheuristic is not rocket science and it still yields a good heuristic.

In conclusion, matheuristics have been experimentally proved to be very effective in solving hard optimization problems. Even if getting the best possible matheuristic for your problem may require a fine tuning, a very direct and simple implementation is already a good competitor to any kind of heuristics. They definitely deserve more attention and any interested reader should give a look to the survey in [4] (even if the literature review is mainly devoted to scheduling problems) and the seminal papers [1 3, 5].

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Resource allocation and planning at a regional Red Cross branch in Austria

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3. Ambulance / First Aid Services, Vienna Red Cross
4. State Rescue Commander, Vienna Red Cross

Introduction

The Vienna Red Cross (Wiener Rotes Kreuz - WRK) is one of the nine regional associations of the Austrian Red Cross, which in turn is part of the International Red Cross and Red Crescent Movement. Its role is as for the National Society

of the Austrian Red Cross described below. Today, the WRK employs around 2000 people on a full-time basis (all subsidiaries included), and some 2000 volunteers. The Vienna State Association is the WRK's parent organization. This also includes several subsidiaries such as a children's hospital and a training centre as well as trade and service companies.

The National Society of the Austrian Red Cross was founded in 1880 as a national institution of humanitarian aid, has a federal structure and consists of regional associations and 133 district offices with nearly 10,000 full-time and some 75,000 volunteers. From the day of its foundation, it was clear how the organization wanted to work: to help neutrally, independently and altruistically those who need its help. A variety of activities include: rescue services, a blood donation service, health and social services, disaster prevention, relief and development cooperation, dissemination of international humanitarian law, a migration and search service, education and training and youth work in the Youth Red Cross.

The Problem

During the past few years the WRK realised that its software for allocating staff to tasks no longer met its requirements. For example, the old software that has been in use in the area of rescue services provided routines for assigning employees to specific tasks, but was limited and only based on availabilities and affiliations of a maximum of two employees or of one employee to a certain vehicle. Hence, a main drawback of the previous system was that only parts of a schedule were calculated automatically, while the system was not able to take into account the various legal regulations, especially time-related restrictions. The WRK invested a lot of time on formulating their requirements for new software, well before starting the software project itself, and invited the software company Ingentus to assist it. Ingentus was founded in 2012 as a spinoff from the Institute of Production and Logistics of the University of Natural Resources and Life Sciences in Vienna. Its main goal is to develop software for efficient resource



▲ Marco Oberscheider/Ingentus



▲ Jan Zazgornik/Ingentus



▲ David Oberleitner
Vienna Red Cross, © WRK

planning, based on state-of-the-art optimisation methods. Ingentus' team focuses on solving real-life logistical problems. For this purpose, the company develops web applications that help customers to digitize their business processes, while containing modules based on metaheuristics to enable 'just in time' decision support.

The Resource Planning Software Tool (RPT)

One of the main features of RPT is that it can be used in nearly all the different areas of WRK, thereby eliminating the limitations of the former fragmented software architecture. Dealing with varying planning areas also leads to the requirements of handling different time horizons (from daily to quarterly), some pre-defined shifts, and legal regulations (e.g., due to various terms of employment, like full time or part time employees, volunteers and civil servants). Hence, they can be used as input (e.g., rescue services), while other areas only dictate the weekly regular working hours (e.g. assistance to the homeless), i.e. shifts have to be generated by assigning tasks. As examples, the objectives and some main parameters of the rescue services and assistance to the homeless are described below, as rather heterogeneous representatives of the underlying problems of the different areas:

- **Homeless assistance:** Computation of a quarterly working schedule for each employee of a given facility. The input consists of given regular working hours, favoured working and free times, as well as of the predefined demand of the facility.
- **Rescue services:** Computation of the assignments of the given shifts of the employees as well as the given vehicles to the predefined open positions of the daily demand. Furthermore, these take into account affiliations of employees to vehicles, employees to locations and between employees, and reduce assignments of overqualified staff.
- As a further difference in the approach, it can be stated that in the rescue service "more vehicles with the same available resources" is better, whereas for helping the homeless exactly the required number of positions should be filled.

The project continues to be managed by a close cooperation of the WRK's in-house IT-department and Ingentus. Following an agile software development process, the WRK always has been involved, while the technical work was mainly done by experts of Ingentus. The Project Leader and Senior Developer worked on back end services including Operations Research methods, and the Junior Developer focused on front end programming. The team was completed by its User-Experience Expert, who designed the navigation within the software from a customer's point of view, as well as others who were significantly involved in the design of the software architecture itself, and also during its implementation.

The software is designed as a web service and therefore runs in any web-browser such as Mozilla Firefox, Brave or Google Chrome. It enables a dispatcher to, for example, manually assign resources to given positions, change locations and times or change the composition of required units.

The project of programming the required ERP (*Enterprise Resource Planning*) system was divided into two consecutive stages. The first part focused on the implementation of the data handling software as well as on interface programming to embed RPT in the given system landscape of WRK. The second part focused on the development of the automatic scheduling algorithm.

The latter algorithm starts with a pre-processing phase where the input data is prepared for further calculation. The initial solution is computed by a regret heuristic (*ref 1*). Afterwards, it is iteratively improved by a metaheuristic based on Adaptive Large Neighbourhood Search (ALNS) where different 'destroy and repair' operators (*ref 1*) are used. In each iteration the operators are used on the current solution, which is first 'ruined' by one of the destroy operators and afterwards 'recreated' by one of the repair operators. The thereby newly generated solution's objective value is afterwards compared to the one of the best known solution to see if it should become the new incumbent solution for the next iteration.

The following 'destroy' operators have been implemented: Random Removal, Related Removal and a tailored operator that focuses on destroying non-deployable units. Regret-k-heuristics that differ in the number of candidates considered in computing the regret value ($k = \{1, 2, 3, 4\}$) are used as repair operators.

The objective here is to maximise the fairness for all resources and to assign as many free positions as defined in the demand or where possible if the given demand can't be fulfilled. The fairness score is based on different factors to:

- reduce extra hours,
- consider wishes of employees and volunteers (certain positions, free time, work time),
- consider affiliations between employees, from employees to vehicles and from employees to work locations,
- distribute weekend shifts of the staff equally,
- build blocks of days of vacation or work,
- reduce overqualification,
- minimize the deviation to the specified weekly working hours.

To solve the problem soft and hard constraints are considered. While hard constraints have to be met in order to obtain a feasible solution, the violation of soft constraints is allowed, but tends to be reduced by predefined penalties. The factors that are summed to get the fairness score are typically expressed by soft constraints, while e.g., minimum qualification or legal working time regulations are defined as hard constraints.

After pre-processing and the computation of the initial solution, the metaheuristic typically gets 30 seconds to enhance the given solution. Afterwards the best-known solution is returned and visualized for the user. The user interacts by taking over the suggested assignments, while he/she has the possibility to decide for each assignment individually, if he/she wants to follow the suggestion of the algorithm (Fig. 1).



▲ Figure 1: Screenshot of a result of automatically planning a schedule for rescue services. The dispatcher can assign the suggested 176 positions at once. Note: the names of the used resources (personnel and vehicles) have been blurred to protect data privacy

Results

The results of the software development process were reported to representatives of the different areas of the WRK at three-weekly project meetings, while correspondence with the product owner and the project manager of the Vienna Red Cross (WRK), was exchanged at least weekly. This ensured that the work met the requirements of the WRK, and adaptations could be made quickly and in an early stage of the development. The main part of the Resource Planning Tool, after two years of development, has been used in WRK's daily business by duty planners since April 2023 (Ambulance Service, Social Services, Internal Service Providers, Disaster Relief Service, Medical Service). WRK implemented an internal learning platform for the new software to support employees when working with the new platform. So far, the results of the automatic planning algorithm have their main impact on the area of rescue services of WRK, where it is used daily. In this area it was thereby possible to reduce considerably the number of daily hours spent in the planning process. To exploit the advantages of the automatic planning algorithm for other areas of WRK, the automatic planning algorithm needs to be improved, which will be the main focus of the upcoming months. Some of the biggest challenges will be to include the time-related law regulations as well as to fully implement all factors needed for the fairness score.

Statement by David Oberleitner, MSc / Vienna Red Cross

"Introducing "RPT" - our brand-new software designed specifically for the Viennese branch of the Red Cross - a powerful planning tool aiming to significantly improve the organization of personnel and material resources during emergency situations as well as daily operations. We are delighted to say that we were able to renew a significant part of



▲ Vienna Red Cross, © WRK/Armin Fauland

our resource planning tools in collaboration with the project's stakeholders. As requested, duty scheduling can be done in different ways. Employees can either request specific shifts or they can be planned directly by shift scheduling personnel. Additionally, the planning can be done automatically, based on different working-shift-models. The built-in intelligent algorithms help planning personnel and material resources in the most efficient way. By optimizing planning processes, "RPT" aims to reinforce the efforts of our local branch in serving and assisting the community consistently. Together, we can build a more resilient world where effective planning and resource management play a pivotal role in providing aid and support for those who need it most. We are excited to see our software empowers our local branch of the Red Cross and contributes to our humanitarian work."

Reference (1): Pisinger, D., Ropke, S., 2010. Large neighbourhood search. In: M, G., J-Y, P. (Eds.), *Handbook of Metaheuristics*. Springer, pp. 399–419. 🌐

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CONFERENCES

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More than 6,500 attended #INFORMS2023 in Phoenix!

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* A version of this article was originally published in the *INFORMS* member magazine *OR/MS Today*.



▲ Downton Phoenix



The 2023 *INFORMS Annual Meeting*, held Oct. 15-18 in Phoenix, Arizona, saw the world's leading minds in operations research (O.R.), analytics, AI, machine learning, data science and more converge for a transformative experience. This premier event offered a unique platform to explore the forefront of research, exchange knowledge and connect with peers from the *INFORMS* community around the globe.

The Phoenix Convention Center in downtown Phoenix hosted more than 6,500 students and academic and industry experts for a one-of-a-kind opportunity to connect with the *INFORMS* community, as well as network with prospective employers and employees.

The theme for the 2023 *INFORMS Annual Meeting* challenged professionals to find new ways to tackle one of the National Science Foundation's 10 Big Ideas [1]: "Harnessing the data revolution" ... all with the power of *OR/MS*!



▲ Attendees arriving at Meeting.

In addition to the tremendous growth in volume, velocity and variety of data in today's digital age, technological advancements such as cloud computing, big data analytics and artificial intelligence (AI) have enabled the data revolution to continue to evolve.

With *OR/MS* and analytics uniquely positioned to play a key role in addressing this challenge by developing new methods

and techniques for collecting, analyzing and interpreting data, the 2023 *INFORMS Annual Meeting* provided a platform for researchers, practitioners and industry leaders to come together and explore these ideas, share insights and experiences, and work together to develop innovative solutions to the challenges posed by the data revolution.

Highlights from Phoenix

Attendees of #*INFORMS2023* were provided with myriad opportunities to gain valuable new insight and network, from the full spectrum of session content, to career development at the Career Fair, and so much more.

Cutting-edge research presentations. Attendees immersed themselves in a vibrant intellectual environment as esteemed researchers presented their groundbreaking work. From novel mathematical models to innovative algorithmic approaches, the evolution of the field was showcased firsthand

with more than 6,000 talks and poster presentations.

Inspiring plenary speakers. A captivating lineup of influential thought leaders shared their visions and expertise. The lineup of plenary speakers included *Daniel Kuhn* (IFORS Distinguished Lecturer), who discussed distributionally robust optimization; *John Halamka* (Mayo Clinic) on the power of platforms to transform healthcare; >>

>> and *David Simchi-Levi* (MIT) on integrating online and offline learning to improve decision-making in operations management. In addition, *Anne Robinson* (Kinaxis) moderated a panel session on supply chains, featuring *Derrick Fournier* (Bristol Myers Squibb), *Pascal Van Hentenryck* (Georgia Institute of Technology), *Kelly Thomas* (Worldlocity) and *Feryal Erhun* (Cambridge Judge Business School).

idea exchange.

Career development. The *INFORMS Career Fair* connected jobseekers and potential employers to share insights into industry trends, learn about emerging career opportunities and conduct interviews.



▲ Plenary Speaker *John Halamka*.



▲ Plenary Speaker *Daniel Kuhn*.



▲ Plenary Speaker *David Simchi-Levi*.

Interactive workshops and technology tutorials. Led by experts in various domains, these interactive sessions equipped attendees with practical tools, techniques and methodologies to tackle complex challenges and enhance their skills and expand their knowledge.

Networking opportunities. Members of a diverse and global community of professionals, academics and industry leaders connected to share their passion for operations research and analytics. Attendees forged meaningful connections during coffee breaks, networking receptions and special interest group meetings, engaging in stimulating discussions and



▲ *INFORMS Career Fair*.

TutORials. Attendees were provided access to the 2023 volume of *INFORMS TutORials in Operations Research*, which includes 11 inspiring, timely and educational chapters highlighting new methodologies and applications that advance the frontiers and push the boundaries of *OR/MS*, motivated by big data and the adoption of emerging technologies, such as the Internet of Things, edge and cloud, as well as AI and data mining, contemporary issues faced by supply chains, and humanitarian and military decision-making.

Conference app and resources. The *INFORMS* app provided access to the schedule, session details, interactive maps, real-time updates, and the ability to interact and connect with fellow attendees. Not only a terrific tool for navigating the *INFORMS* conferences, but the app helps members stay in touch with *INFORMS* throughout the year!



▲ *Pro Bono Analytics*.

New This Year

The 2023 INFORMS Annual Meeting included attendee favorites such as the pre-meeting workshops (including Early Career Teachers' Network, Combined Colloquia, Data Science Workshop and more!), technology tutorials, poster sessions and the Tuesday night General Reception!

This year's conference also had a few new and improved agenda items:

- Panel plenary: "Harnessing the Data Revolution in Supply Chains" brought together a panel of experts with decades of experience to look at supply chain issues and share perspectives on what areas represent the most promise and the most peril.
- Specially curated "Committee's Choice" sessions: These sessions featured presentations hand-selected by the 2023 INFORMS Annual Meeting Organizing Committee and took place throughout the meeting [2].
- An opportunity to give back! INFORMS Pro Bono Analytics hosted a special opportunity throughout the conference to give back to the host city by creating care packages for those in need in Phoenix [3].

References

- 1) https://www.nsf.gov/news/special_reports/big_ideas/,
- 2) <https://tinyurl.com/32mpe69t>,



Esma Gel is the Cynthia Hardin Milligan Chair of Business and professor of supply chain management and analytics at the University of Nebraska-Lincoln. She is general co-chair of the 2023 INFORMS Annual Meeting.



Sanjay Mehrotra is a professor in the Department of Industrial Engineering and Management Sciences at Northwestern University. He is general co-chair of the 2023 INFORMS Annual Meeting.

3) <https://meetings.informs.org/wordpress/phoenix2023/pro-bono-analytics/>.

Cordially thanks to dear **Ashley Kilgore**, for communication and help to make this particular reprint possible.
G.-W. Weber 🌍

International Annual Conference of the German OR Society 2023: Fresh Ideas in the Free and Hanseatic City of Hamburg

Rainer Kolisch <rainer.kolisch@tum.de>

This year's annual international conference of the *German OR Society* was held under the motto "Decision Support & Choice-Based Analytics for a Disruptive World" from August 29 to September 1, 2023, at the University of Hamburg, jointly organized by the *University of Hamburg* and the *Kühne Logistics University (KLU)*. The organizing committee was chaired by *Guido Voigt* (University Hamburg) and the program committee was chaired by *Malte Fliedner* (University Hamburg). The conference had 756 participants from 35 countries, 536 presentations, 162 sessions, 2 plenary lectures, and 7 semi-plenary lectures. On the pre-conference day, a special program was offered for PhD-students, in which about 150 students took part. First, *Knut Haase* (University of Hamburg) gave a tutorial on *Choice-Based Optimization* and afterwards, three former PhD-students presented successful OR-implementations in different industries such as container terminals, sports, and beer brewing.

At the opening ceremony of the conference, the scientific price of the German OR Society, sponsored by *INFORM GmbH*, was awarded to *Anita Schöbel* (University Kaiserslautern-Landau). In her talk "Why OR is great - A personal view on my favorite discipline", the laureate gave an overview of her research, starting with the determination of hyperplanes in location planning to the minimization of delays in public transport, to robust optimization, integrated planning, and the use of quantum computers by *Operational Research*.



▲ Main building of the University of Hamburg with the conference banners of OR 2023.

Supported by Gurobi, the following PhD-theses were awarded with the PhD-price of the German OR society: *Marianne Guillet* (Technical University of Munich): "Balanced Electric Vehicle Charging under Uncertainty: From User Centric to System Centric Approaches", *Kai Hoppmann-Baum* (Technical University of Berlin): "Mathematical Programming for Stable Control and Safe Operation of Gas Transport Networks", *Matthias Soppert* (University of the Armed Forces Munich): "Demand Management in Shared Mobility Systems", and *Julia Sudhoff Santos* (University of Wuppertal): "Ordinal Costs in Multi-Objective Combinatorial Optimization".

The *Young Researcher Award* of the German OR Society, which is awarded for outstanding publications by young researchers in the journals *OR Spectrum* and *Mathematical Methods of Operations Research* was awarded to *Michael Dienstknecht* (University of Wuppertal) for the paper "The traveling salesman problem with drone resupply" and to *Johannes Thürauf* (Friedrich-Alexander University Erlangen-Nuremberg) for the paper "A bilevel optimization approach to decide the feasibility of bookings in the European gas market".

Two *plenary talks* were given. The first one by *Nils Kemme* (Managing Director at Hamburg Port Consulting GmbH) on the topic "Out of the Box Thinking - Real Life OR Applications for Container Terminals". In his presentation, *Nils Kemme* addressed three exemplary planning problems of container terminals: the Container Stacking Problem, the Maintenance Problem, and the Charging Management Problem. *Nils Kemme* convincingly showed how machine learning is already successfully applied in these three planning areas and what opportunities are available for Operations Research in solving planning problems in container terminals.

The second plenary talk was given by *Huseyin Topaloglu* (Cornell University) on "Incorporating Discrete Choice Models into Revenue Management Decisions". *Huseyin Topaloglu* presented the development of discrete choice models for deciding which products to offer to incoming customers in digital sales portals in order to maximize expected revenue. The talk provided an excellent overview of current approaches to static and dynamic models as well as the associated methodologies.

The seven semi-plenary presentations also demonstrated the contributions that *Operational Research* makes to timely planning problems: *Ana Paula Barbosa-Póvoa* (Universidade de Lisboa): "Driving Supply Chain Sustainability: The Crucial Role of Optimization in Achieving Sustainable Practices", *Christoph Weber* (University of Duisburg-Essen): "OR-models for the energy transition - coping with uncertainty and heterogeneity", *Joanna Józefowska* (Poznan University of Technology): "Models for just-in-time scheduling", *Max Klimm* (Technische Universität Berlin): "Information



▲ At the reception of the Senate of the city of Hamburg (from left to right): *Andreas Kaplan* (President of Kühne Logistics University), *Katharina Fegebank* (Senator for Science, Research and Equality of the City of Hamburg), *Guido Voigt* (Conference Chair), and *Tilo Böhmann* (Vice President for Research of the University of Hamburg).

Design for congested networks", *Sally Brailsford* (University of Southampton): "Improving emergency care using a new approach to generic simulation modelling", *David Manlove* (University of Glasgow): "Models and Algorithms for Kidney Exchange", *Sven Müller* (RWTH Aachen University): "Locational choices and decisions: choice-based facility location planning".

The excellent scientific part of the conference was complemented by the great social program. On the eve of the conference, the welcome reception took place at the University of Hamburg, providing a great opportunity to meet old friends and make new friends. After the first conference day, the Senate of the city of Hamburg invited the participants at the Kühne Logistics University, in the new district of the Hafencity, right next to the waterfront. Welcome addresses were given by *Katharina Fegebank* (Senator for Science,



▲ The Chairman of the OR 2023 conference *Guido Voigt* at the Opening Session.

Research and Equality of the City of Hamburg), *Andreas Kaplan* (President of Kühne Logistics University) and *Tilo Böhmann* (Vice President for Research of the University of Hamburg). The social highlight of the conference was the conference dinner at the Grand Elysee Hotel where specialties of the North German cuisine were served to the participants.

The conference ended with the invitation for next year's *International conference of Operations Research*, organized by the OR societies of Germany, Austria, and Switzerland, which will take part at the Technical University of Munich in Munich, Germany, see <https://www.or2024.de>. 🌍

OR65 Conference Highlights: Advancing Operations Research and Inspiring Insights, Hosted in Bath by The OR Society of the UK

John Medhurst <john@larrainzar.co.uk>

The field of *Operations Research (OR)* is an ever-evolving discipline that plays a central role in tackling complex real-world problems.

This year, the *OR Society* proudly hosted its flagship annual conference, *OR65*, in collaboration with the University of Bath's School of Management. This three-day conference brought together a diverse gathering of hundreds of academic and professional operational researchers and analysts, all eager to share the latest developments in OR and explore its real-world applications.

Celebrating 75 Years of OR Excellence

The conference kicked off with a warm welcome from Conference Co-Chairs *Christos Vasilakis*, *Melih Celik* and *Mithu Norris* and the University's Dean, *Stephen Brammer*. However, the real highlight was the announcement by the *OR Society's* President, *Gilbert Owusu* that the society is commemorating its 75th anniversary and has launched a new campaign '*This is OR*'; aimed at increasing awareness of *OR* and its profound impact across various industries.

With the growing demand for individuals skilled in data analytics, mathematics, and computer science, the campaign will highlight the diverse and attractive career opportunities within the *OR* field. It targets students, graduates and postgraduates in business management and sciences, as well as professionals already working in data science and analytics. It will also highlight that the *OR Society* can provide a huge range of resources, courses, scholarships, publications, and networking opportunities to support those working in this exciting field.

World-Class Speakers

OR65 featured an impressive line-up of plenary speakers, each contributing their unique insights and expertise to the conference.

Prof. Dr. Erik Demeulemeester, a distinguished researcher in project scheduling and healthcare planning, took the stage to discuss '*Proactive and Reactive Resource-Constrained Project Scheduling*'. His presentation focused on this challenging area where project activities' durations are marked by uncertainty. *Prof. Demeulemeester* explored the intricacies of proactive scheduling, which aims to construct robust baseline schedules capable of withstanding potential disruptions during project execution. He also delved into reactive scheduling procedures designed to mend schedules when unexpected events change the original plan. He provided insights into cutting-edge approaches in this critical field.

We also heard from *Prof. Maria Besiou*, Dean of Research and Professor of Humanitarian Logistics at Kühne Logistics University on the fascinating '*Impact of OR in Humanitarian Operations*'. She discussed the complex challenge of using *OR* to plan for humanitarian disasters that are unknown



▲ Plenary Speaker *Professor Mauricio Resende* engaging delegates covering four decades of experience in academia and industry!

and simply can't be planned. One of the key challenges in humanitarian *OR* is demonstrating impact. Her presentation shed light on the challenges and opportunities in achieving broader impact and strengthening the connection between research and practice.

On the final day, we heard from *Mauricio G. C. Resende*, Ph.D. on '*Bridging Academia and Industry*'. *Mauricio* is an Affiliate Professor of Industrial and Systems Engineering at the University of Washington, and he shared insights from his remarkable four-decade-long career journey, and how he has personally bridged the gap between academia and industry. *Mauricio* is most renowned for his work in metaheuristics and algorithm engineering, making significant contributions to optimisation. He shared his experiences collaborating with industry giants such as Fairchild Semiconductors, AT&T Bell Labs, and Amazon Research. He also highlighted the inception of GRASP and BRKGA, two pivotal algorithms that were rooted in these collaborations.



▲ A day full of thought provoking and interactive workshops as part of our *Making an Impact* stream.

A Broad Range of Streams

OR65 featured an impressive array of lectures and workshops, covering a wide range of topics, including AI and Machine Learning, Sustainable Development Goals, Behavioural *OR*, Forecasting Solutions, *OR* in Health and Social Care, *OR* in Education, Hybrid Modelling and Simulation, >>



▲ Our 75th anniversary Presidents Medal finalists... (left to right) Adam Jones, Clifford Williams, Shakeel Khan.

>> and OR in Achieving Net Zero. One of the most captivating streams was "Making an Impact", where attendees learned about real-life applications of OR and new techniques and tools that can help them 'Make an Impact' in their work.

President's Medal Winner

A highlight of the conference was the *President's Medal* competition, an annual award that recognises the most outstanding practical application of OR.

Adam Mackenzie-Jones, the Net Zero Systems lead within the Net Zero Strategy Directorate at the Department for Energy Security & Net Zero, emerged as the winner of the President's Medal 2023. He was honoured for creating a ground-breaking Net Zero Systems tool for use in government departments.

Tackling the complex challenge of achieving Net Zero emissions targets requires collaborative efforts across various government departments. To facilitate this, Adam and his team collaborated with various government bodies to design and

create an innovative interactive visualization tool called the Net Zero Systems Tool (NZST). This tool empowers decision makers to understand and navigate the interconnected and systemic nature of this landscape, enabling effective risk management, identification of opportunities, and driving further collaboration across government.

Conclusion

OR65 offered a glimpse into the vibrant and evolving world of *Operations Research*. The conference provided a platform for the OR community to connect, share knowledge, and address some of the world's most intricate challenges. As the OR Society commemorates its 75th anniversary, the enduring legacy of OR's contributions to society stands stronger than ever. Next year, OR enthusiasts will gather at the University of Bangor – we look forward to seeing you all there.

John Medhurst is the Chair of the OR Society Events Committee. 🌍



▲ *Women in OR and Analytics*, a special drop in session at OR65 which welcomed many delegates.

Workshop Next Generation Digital Ports (NGDP) Successfully held as a Pre-Conference of the Cluster Maritime Logistics of IFORS 2023, in Valparaíso, Chile

Rosa G. González Ramírez <rgonzalez@uandes.cl>

The Workshop "Next Generation Digital Ports" (NGDP) was held at the Pontifical Catholic University of Valparaíso (PUCV), July 4-7, 2023. The event was organized under the scope of a program sponsored by the National Agency for Research and Development (ANID by its acronym in Spanish) to strengthen the formation and consolidation of high-level scientific research networks and proposed to be held the prior week to the IFORS 2023. NGDP promoted the participation of senior and young academics from different regions in Chile, as well as internationally renowned and experienced researchers, aimed at generating knowledge and solutions to address challenges in the maritime port sector, focusing on infrastructure and capacity analysis, resilience, agility, and logistics interoperability based on digital transformation. NGDP has been led by Rosa González, from the University Los Andes Chile, and the local team includes Jimena Pascual as the host of the event of the Pontifical Catholic University of Valparaíso, Karol



▲ Working group session: Port infrastructure and capacity challenges and opportunities from an OR perspective.

Suchan of the University Diego Portales, Claudio Alvarez of the University Los Andes Chile and Sebastian Muñoz of the Catholic University of the Saint Concepcion. >>

>> In total, 31 academics participated, of which 16 were international, visiting us from five countries: United States, Mexico, Colombia, Netherlands, and Germany. It also considered the participation of 11 students. Among these participants, 20 academics and 6 students also participated in the *IFORS* conference. During the *IFORS* Conference, *Eduardo Lalla* (University of Twente, The Netherlands) and *Rosa Gonzalez* (U. Andes Chile) chaired the cluster “*Maritime Logistics*” with 24 contributions in 6 sessions and the Tutorial “*Seaside Planning: overview and implementation*”.

The *NGDP* included activities with the local maritime and port industry. For this, two activities were organized. First, a workshop in the *Port of San Antonio*, at the facilities of the Port Authority of San Antonio with the support of the *General Manager*, and the *General Manager* of the *Port Logistics Community COLSA*, *Pilar Larrain*. During the seminar, three of the invited academics delivered a talk. First, *Julio Mar* of the *Autonomous University of Tamaulipas* in Mexico talked about the community engagement activities of his research group with the Port of Altamira in Mexico. Then, *Gordon Wilmsmeier* and *Cristiam Gil* of the University Los Andes Colombia and *Kühne Logistics University* (KLU, Germany) presented their research in the area of port performance from the perspective of emissions and land transportation, as well as port integrity. Furthermore, executives of the port authority explained the expansion plans and technological development of the Port of San Antonio. The activity included a technical visit to the facilities of one of the port terminals, *San Antonio International Terminal (STI)*.

The second activity was held at the facilities of the *Port Authority of Valparaíso (EPV)*. It considered the participation as



▲ Group picture with some of the participants.



▲ Visit to the facilities of *San Antonio International Terminal*, of the Port of San Antonio, Chile.

keynote speaker of *Tom O'Brien* from California State University Long Beach (CSULB) who presented the Decarbonization program of the Port of Long Beach and the collaboration that the university has with the port. Then, executives of the port authority also introduced the port development plans and technological projects and achievements of the port to the audience. Finally, a panel was performed, organized by the *Foundation Connect Logistics*, an institution created by the Ministry of Transport in Chile. The panel was moderated by *Margarita Amaya*, with the participation of the international speaker *Stefan Voss*, the general manager of the port terminal TPS *Oliver Weinreich*, *Patricio Oyarzo* of the Ministry of Transport in Chile, *Rosa Gonzalez* of the University Los Andes Chile and *Daniella de Luca* from the Universidad de Valparaíso. The seminar was coordinated with the support of *Carlos Carcamo* of the Port Authority of Valparaíso. An audience of around 100 participants included also representatives from the different stakeholders of the port community *FOLOVAP*.



▲ From left to right, *Cristiam Gil* (U. Andes Colombia & KLU, Germany), *Eduardo Montecinos* and *Jorge Santos* (Port Authority of San Antonio), *Gordon Wilmsmeier* (U. Andes Colombia & KLU) and *Julio Mar* (Autonomous U. of Tamaulipas).



▲ Speakers in the seminar held at the PUCV (left to right, up to down): *Jairo Montoya* (U. Sabana), *Stefan Voss* (Hamburg U.), *Tom O'Brien* (California State U. Long Beach), *Frederik Schulte* (Delft T.U., The Netherlands).



▲ Speakers in the seminar held at the Port of Valparaíso. From left to right: *Juan Marcos Mancilla* (EPV), *Oliver Weinreich* (South Pacific Terminal), *Tom O'Brien* (California State U. Long Beach), *Patricio Oyarzo* (Ministry of Transport), *Margarita Amaya* (Foundation Connect Logistics), *Rosa Gonzalez* (U. Andes Chile), *Stefan Voss* (Hamburg U., Germany) and *Enrique Piraino* (EPV).

The workshop featured some lectures of selected academics that presented research projects related to digital transformation and decarbonization at ports. In this regard, *Jairo Montoya* from the University La Sabana talked about the experiences from the project EPI-Center and results of the survey to evaluate the level of adoption of industry 4.0 technologies, *Stefan Voss* from *Hamburg University* presented the current results of the Digital Twins project with the Port of Hamburg, *Tom O'Brien* talked about the experiences from the CITT center and its relationship with the Port of Long Beach and training programs, and *Frederik Schulte* of the Technical University of Delft talked about *Decarbonization Projects* and the Role of *Operations Research and Machine Learning* at the Port of Rotterdam.



▲ Working group session: digital transformation in ports. *Karol Suchan* (U. Diego Portales), *Claudio Alvarez* (U. Andes Chile), *Stefan Voss* (Hamburg U.), *Gonzalo Mejía* (U. Sabana) and several students.

Social activities were also considered, including a kick-off dinner on the first day of the seminar, and a tour of the main locations in the historical city of Valparaíso as well as in *Viña del Mar*. The media partner was *Porthink*. Some reports (in Spanish) of the event can be found at: <https://porthink.com/5-de-julio-seminario-presencial-puertos-digitales-de-nueva-generacion-san-antonio/>, <https://portalportuario.cl/seminario-puertos-digitales-de-nueva-generacion-analiza-avances-tecnologicos-de-puerto-san-antonio/>, <https://www.mascontainer.com/epv-organizo-seminario-de-digitalizacion-y-desarrollo-portuario/>, <https://todologisticanews.com/site/puerto-de-valparaiso-implementa-silogport-3-0/>. 🌐



▲ Working group session: students with *Julio Mar* (U. Autonoma Tamaulipas), *Alice Smith* (U. Auburn, USA) and *Jimena Pascual* (P.U.Catolica Valparaíso).

During the last day of the event, working group activities were organized to discuss topics related to the challenges and opportunities in three research lines from an *OR* perspective. Three groups were formed, one analyzed challenges on port infrastructure and capacity, another analyzed challenges related to digital transformation and interoperability at ports, and the third group focused on the analysis of aspects related to efficiency and agility of port operations. The different groups aimed to debate opportunities and also to identify potential collaborations among the participants.



▲ Visit to the *Port of Valparaíso* in Chile.



▲ *Kick-off dinner* during the first day of the event.



▲ Several participants at a coffee break in the *Port of San Antonio*.



▲ *Jimena Pascual* (PUCV) at the welcome opening of the seminar in the *Port of Valparaíso*, *Luis Ascencio* and *Rosa González* (U. Andes Chile) at the seminar in the *Port of San Antonio*, and some of the graduate students that participated.

7th IMA Mathematics in Defence and Security Conference Successfully held at Imperial College London. Supported by Operational Research

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The 7th IMA Mathematics in Defence and Security Conference held at Imperial College London on September 7 brought together over 80 delegates representing government, industry, and academia. The conference marked a departure from its historical emphasis on physically modelling systems to address contemporary challenges posed by artificial intelligence (AI) and quantum computing in the realms of defence and security (<https://ima.org.uk/20850/7th-ima-defence/>).

The conference opened with a captivating keynote address by *Prof Richard Pinch*, tracing the historical challenges faced by mathematicians in security and their exciting opportunities in the era of quantum computing. Presentations throughout the day reiterated the significance of AI and quantum computing, reflecting their increasing use and potential threats and opportunities in the defence and security landscape.

Defence Science and Technology Laboratory (Dstl) presented five substantial mathematical challenges confronting future defence AI. These challenges encompassed topics ranging from “scalable hypergraphs” to the cognitive dimensions of AI understanding. This presentation was a rallying call for the mathematical community to address these pressing issues collaboratively. We then moved on to a practical example of using quantum hybrid methods as a promising avenue for autonomous cyber defence systems. These methods offer potential solutions for rapid incident response from limited data sets. Nevertheless, practical challenges tied to quantum device limitations and access constraints were highlighted.

Rachel Craddock's (Thales) keynote presentation explored the intricate collaboration between AI and humans. She emphasised the role of mathematics and mathematicians in bridging the gap between imprecise human communication and precise computer communication. The question of whether AI would function as desired when needed was addressed, underlining mathematics as a key determinant of AI success.

Two detailed technical presentations showcased the application of more applied physics based mathematics. Geometrical approaches for over-the-horizon radar and statistical methods for chirp signal detection demonstrating the potential of mathematical approaches in tackling complex challenges.

Next the concept of *Variety Dynamics* introduced a novel



▲ *Prof Richard Pinch* opens the conference with his keynote presentation: “Mathematical challenges in security”.

mathematical approach to handling complex defence and security scenarios. Unlike traditional methods, this approach does not rely on causal relationships but addresses strategic decision-making and control management differently.

In our third keynote *Richard Lane* (QinetiQ) shed light on behavioural analytics, enabling insights into individual and crowd behaviour. Mathematical technologies, including Bayesian networks, state estimation algorithms, and machine learning, were highlighted for multilanguage quote analysis and behavioural prediction.



▲ *Dstl* put out to the community their “Five Mathematical Challenges in AI”.

We then moved on to a *Dstl* presentation of an alternative to traditional Monte Carlo simulations, focusing on evaluating the probabilities of chains of events. This approach offers a cost-effective and efficient method for modelling scenarios, with promising applications beyond defence.

An optimisation framework called *MIDAS* was introduced, showcasing its potential in aiding decision-making processes. Practical examples, including locating transmitters and controlling drones, highlighted the adaptability of this mathematical tool.

Recognising the growing use of influence in the conduct of conflict we were briefed on some work involving game theory principles to explore the effectiveness of sanctions and trade embargoes. Predictive models played a pivotal role in maximizing the impact of these measures, using a Bi-Layer model for international trade.

Our final keynote was from *Prof Tim Watson* from the Turing Institute. *Tim* provided insights into the institute’s history and future vision, particularly Turing 2.0. >>

>> During the talk *Tim* provided some excellent examples of where the use of mathematics had made a significant impact in addressing some of the serious challenges facing decision makers across the breadth of defence and security. *Tim's* talk concluded by outlining the grand challenge for Defence and Security and encouraged researchers to contribute to this initiative. He explained how the challenge was deliberately difficult so as to really set the bar high: some level of failure could still result in key insights being learnt!

Moving into the final session of the day we heard of the novel use being made in the development of efficient algorithms for detecting and quantifying symmetries in hypergraphs. This work showcased how symmetries can significantly reduce computational time in downstream analyses.

The final presentation addressed stochastic strategies for UAV navigation in border patrolling operations. The objective was to develop a stochastic strategy for aspects of UAV navigation, considering the minimisation of time required to complete the mission while maximising the probability of success of the mission. The test scenario using a student trying to locate their tutor on campus was probably far more challenging than any defence and security scenario!

Overall, the 7th IMA Mathematics in Defence and Security Conference provided a comprehensive exploration of contemporary mathematical challenges and solutions in the field of defence and security, supported by modern OR. By focusing on AI, analytics, optimization, quantum computing



▲ *Richard Lane* presents his paper "Behavioural Analytics: Mathematics of the Mind".

and various quantitative methodologies, the conference underscored the critical role of mathematics in addressing complex security issues. It served as a valuable platform for interdisciplinary collaboration and networking, fostering innovation and insights in this ever-evolving landscape.

Looking forward to the next one!

The authors, *Kevin Wagstaff*, *James Andrews*, *Natalie Flaherty*, and *Alexandra Tzella*, were members of the Organising Committee.

Cordially thanks to dear *Maya Everson*, for communication and help to make this report possible.
G.-W. Weber 🌍

International Conference on Data Envelopment Analysis – DEA45 Held on September 4-6, 2023, at Surrey Business School, University of Surrey, UK

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The conference marked the 45th anniversary from the publication in 1978 of the seminal paper on DEA. Since that time, DEA has grown into a cutting-edge methodology for assessing and managing efficiency and productivity from a variety of perspectives and across all sectors of the economy. The vibrancy of DEA is reflected in thousands of academic and applications papers, chapters, books and consultancy documents.

The host *University of Surrey*, is situated on a picturesque green campus just beyond the outskirts of London. The conference was meticulously organized by the Centre for Business Analytics in Practice (CBAP), a multi-disciplinary research hub with a vision focused on leveraging analytics for informed decision-making. The Director of CBAP, *Professor Ali Emrouznejad*, in collaboration with *Emmanuel Thanassoulis*, Emeritus Professor at Aston University were the inspiration and key organisers of the Conference (<https://dataenvelopment.com/dea45/>).

Some 160 delegates attended the conference, hailing from more than 35 countries. The conference featured a diverse array of themes covering both theoretical developments in DEA, as well as applications of DEA in a broad range of areas.



▲ Photographs from the Conference DEA45.

Plenary sessions covered the measurement of efficiency in network industries, courts, education, and air-traffic control agencies. For example, *Professor Conceicao Silva* (Católica Porto Business School, Portugal) critically reviewed DEA literature addressing network structures with a specific application to the functioning of courts in the delivery of justice. *Professor Kristof De Witte* (KU Leuven, Belgium) outlined DEA approaches to identifying the causes of efficiency with special reference to secondary schools in Flanders, Belgium.

Issues of economies of mergers were addressed in *semi-plenaries* by *Professor Subhash Ray* (University of Connecticut, USA), *Professor Nicole Adler* (The Hebrew University, Israel), and *Professor Ole B Olesen* (University of Southern Denmark). *Professor Podinovski* (Loughborough University, UK) delivered a plenary on extending DEA methodology to cases where contextual, resource, or outcome measures are in ratio form, as DEA is primarily a method for handling scale variables. *Professor Léopold Simar* (UC Louvain, Belgium) and *Professor Paul W. Wilson* (Clemson University, USA) presented a semi-plenary on the inference in dynamic nonparametric models of production for general technologies.

Delegates were presented with the choice of five parallel streams and a selection of plenary/semi-plenary sessions. The conference was mindful to offer support to those new to research in the realm of efficiency and productivity.

One particular aim of the conference was to bring together academics and those in the public and private sector using the methods for assessing efficiency and productivity. In this regard a stream was organised featuring presentations and discussion of the use of efficiency and productivity analysis methods in economic regulation. Regulators use such methods in order to estimate the scope for efficiency

savings in regulated network industries such as water, gas and electricity to inform their determinations of price or revenue caps. Contributions from regulators and analysts in the field included those familiar with regulation of energy and water in Finland, Norway, Brazil, the Netherlands and England.

This year, we mourned the loss of *Professor Rajiv Banker*, one of the founders of DEA. A special session, commemorating his legacy, was held during the conference on September 5th, 2023. Esteemed colleagues and researchers gathered to honour his profound influence on the field, emphasizing his seminal role in shaping the foundations of DEA. The session highlighted his intellectual contributions, groundbreaking research, and mentorship, underscoring his lasting impact on the understanding of efficiency measurement in diverse sectors.

The organisers are now looking forward to organising the next DEA conference in the autumn of 2024 at *Birla Institute of Management Technology (BIMTECH)*, Delhi, India (<https://dataenvelopment.com/dea2024/>).

¹ A. Charnes , W. W. Cooper and E. Rhodes (1978) Measuring the efficiency of decision making units, *European Journal of Operational Research* 2, 429-444 🌐

36th National Meeting of Operations Research Teachers and 34th Operations Research Training School: Celebrated in beautiful Santa Rosa, La Pampa, Argentina

Mariana Funes <mcfunes@eco.uncor.edu>, **Mariano Frutos** <mfrutos@uns.edu.ar>

Between the 20th and 22nd of September 2023, the 36th edition of the *National Meeting of Operational Research Teachers (ENDIO)* and the 34th edition of the *Operational Research Improvement School (EPIO)* took place. Following the federal character of these established conference series, the annual meeting was held in Santa Rosa, La Pampa, Argentina, and jointly organised by the Faculty of Economics and Law of the National University of La Pampa and the Operational Research Improvement School (<https://www.epio.net.ar/>).

Since 1988, these meetings have brought together teachers, researchers, professionals, undergraduate and postgraduate students from different university careers, both in the country of Argentina and abroad, who work in *operations research* and related disciplines.



▲ ENDIO-EPIO 2023: the conference given by Prof. Diego Rossit.

During this congress, 42 contributions were presented in 12 parallel sessions, which were developed in a friendly atmosphere, allowing enriching exchanges. Two conferences and two courses covering different topics were also part of the programme:

Conference 1: “Modelling and optimisation tool applications in the context of smart and sustainable cities” by Profs. Sergio Nesmachnow and Diego Rossit.

Conference 2: “Data science and its role in assets management” by Prof. Ignacio Schuttemberge.

Course 1: “Machine learning algorithms fundamentals” by Profs. María Inés Stimolo, Pablo Ortiz and Mgter. Maximiliano Iglesias.

Course 2: “Motivating in the overstimulation digital era” by Prof. Hernán Aldana Marcos.



▲ ENDIO-EPIO 2023: the course given by Prof. Aldana Marcos.



▲ ENDIO-EPIO 2023: Gala Dinner.



▲ ENDIO-EPIO 2023: Group photo.

The meeting also provided a social programme including lunches, a *Welcome Cocktail* and the traditional *Gala Dinner*, which gave the participants pleasant opportunities to connect and to get to know each other better. 🌍

Students and Professors meet in the forests around Bielefeld, Germany, to discuss Data Science and Combinatorial Optimisation: EWG/DSO EURO PhD School

Michael Römer <michael.roemer@uni-bielefeld.de>, Patrick De Causmaecker <patrick.decausmaecker@kuleuven.be>

From September 4th to 8th 2023, Bielefeld University hosted the first *EURO Summer School on "Data Science Meets Combinatorial Optimisation"*. It took place at the campus of the university and offered deepening into five subjects all embodying specific interaction between the two domains (see <https://decision-analytics.github.io/PhD-School-DSO-2023/>).



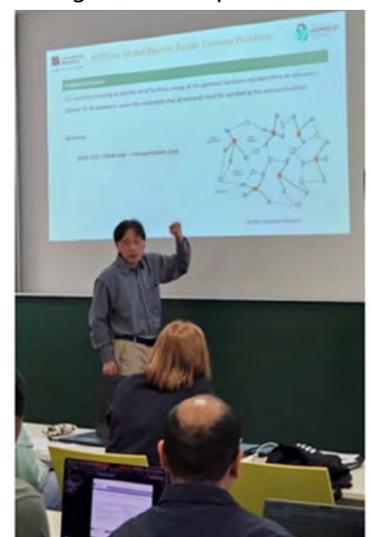
Each of the five days of the PhD school, one or two renowned professors would introduce a specific state-of-the-art topic taken from her or his recent work, hereby often assisted by a post-doc and providing both theory and hands-on training as well as exercises in two or three sessions after which PhD students were prompted to present and discuss on their own, related, work. This already rich program of the summer school was taken to an even higher level in an invited talk by the *Alexander von Humboldt Professor Yachou Jin*. As essential as this scientific enrichment, joint meals and social activities were organized and there was plenty of room for socializing and networking. Given the great weather throughout the whole PhD school week, many participants opted for a daily

hike from the campus through the beautiful *Teutoburg Forest* to the hotel in which all participants and lecturers stayed. The joint dinners at the hotel were held outside with a view on the city of Bielefeld and the medieval *Sparrenburg Castle*.

The aim of the *PhD School* was to study features of algorithms for combinatorial optimization and feature aspects related to data science. The NP-hardness of most combinatorial optimization problems reflects itself in complicated and large solution spaces. The relation to real-world problems and the inherent complexity of the resulting context impacts the set of instances likely to ask for a solution and this influences the applicability as well as the configuration of specific algorithms. Specific algorithms may allow fast solutions for specific classes of instances while performing much worse on other classes. A landscape of instances is the result in which algorithms need to be positioned. Study of this enlarged problem setting increases understanding on the problem and on the applicability of specific algorithms.



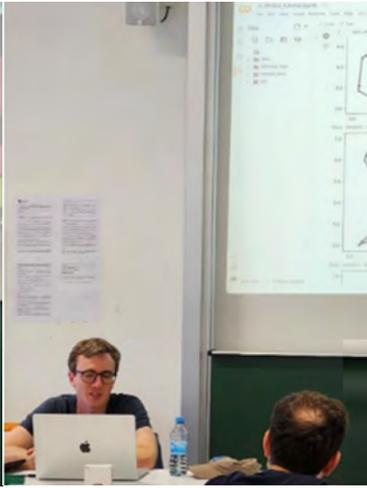
▲ EWG/DSO EURO PhD School: enjoy outside; Young people discuss with Prof. Kate Smith-Miles (left, front).



▲ EWG/DSO EURO PhD School: the lecture by Prof. Yachou Jin.



▲ EWG/DSO EURO PhD School: the lecture by Prof. Marius Lindauer.



▲ EWG/DSO EURO PhD School: the lecture by Prof. Kevin Tierney.



▲ EWG/DSO EURO PhD School: program led by Prof. Yingqian Zhang and Prof. Sicco Verwer (left to right).



▲ EWG/DSO EURO PhD School: the lecture by Prof. Dimitri Papadimitriou.



▲ EWG/DSO EURO PhD School: the Social Dinner.



▲ Profs. Michael Römer, Sicco Verwer and Yingqian Zhang and PhD student Mohsen Nafar enjoying the weather (left to right).

The first day was devoted to 'Deep Reinforcement Learning for Vehicle Routing Problems' and was led by Professor Kevin Tierney of Bielefeld University. This was also the day of the keynote by Professor Yachou Jin on "Graph Neural Networks for Combinatorial Optimization".

On the second day, the subject was "Efficient algorithm design via automated algorithm selection and configuration" by Professor Marius Lindauer and his assistant Alexander Tornado, both from University of Hanover, Germany. In the afternoon, the first session of student presentations took place with four students discussing their work.

The third day was led by Professor Yingqian Zhang from Eindhoven University of Technology and Professor Sicco Verwer from TU Delft both in the Netherlands.

Again, in the afternoon, five students presented and discussed on their projects.

The fourth day was on "Instance Space Analysis" by Professor Kate Smith-Miles from The University of Melbourne in Australia.

In the afternoon, a guided city-walk, and a social dinner in the Sparrenburg Castle offered plenty of opportunities for interaction.

The school closed on the fifth day with a scope-enlarging session on "A third dimension for characterizing algorithms: spatial properties" by Professor Dimitri Papadimitriou of University of Antwerp in Belgium.



▲ Group photo of celebrated EWG/DSO EURO PhD School 2023.

The enthusiasm of the lecturers stimulated a highly motivated audience of 30 PhD students from 22 universities all over Europe. These young scientists had the invaluable opportunity of interacting closely with renowned professors from all over the world, and these contacts may play a role in their future career. The diversity in scientific interest, educational luggage as well as cultural background

proved once more the importance of this kind of interactions. As the organizers know from their own experience, the week has created memories for life. Lasting acquaintances between participants and some long-term collaborative endeavors are bound to emerge. 🌍

EUROPT Workshop 2023 in Budapest: the continuous optimization working group was back home

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EUROPT - the continuous optimization working group of *EURO* XVII. was founded in Budapest on 14 July 2000 on occasion of *EURO* XVII. Since the foundation of the group the conference has been held almost every year and it is one of the major events for the European mathematical optimization community. The location of the workshop has been a European city except for 2011 in Ballarat, Australia, and 2017 in Montréal, Canada.

In order to celebrate the 20th edition, the group was back to Budapest. The workshop was organized by the *Corvinus Centre for Operations Research* of *Corvinus University of Budapest* and the *Hungarian Operations Research Society*, with the sponsorship of the software company *FICO*, on 23-25 August.

The Program Committee was chaired by *Tibor Illés* (*Corvinus University of Budapest*) and co-chaired by *Giancarlo Bigi* (*Università di Pisa*) and *Tamás Terlaky* (*Lehigh University*), and it was composed by 28 *EUROPT* members, including the *EUROPT* Managing Board, as well as some *EUROPT* Fellows and *EUROPT* Past and Honorary Chairs. The Organising Committee was made by 8 people and chaired by *Marianna E.-Nagy* (*Corvinus University of Budapest*).

EUROPT 2023 has been a great opportunity for the community to get together in person again and enjoying sharing the latest developments in continuous optimization. Registered participants were 229 from 34 countries, with the geographical distribution depicted in the figure below (the figure does not include countries with a single participant, namely Chile, Cyprus, Finland, India, Iran, Japan, Kazakhstan, Slovenia, South Korea, Taiwan, Ukraine). Among the participants, 80 were PhD students.

Scientific Program

The rich scientific program of the conference covered all aspects of continuous optimization, and was subdivided in 18 special streams that were held in 6 or 7 parallel sessions. Each session grouped 3 or 4 talks, each on a time slot of 25 minutes.

Three *plenary lectures* were delivered by distinguished scholars: *Russell Luke* (*University of Göttingen*) talked about *Proximal splitting algorithms in nonlinear spaces*, while *Renata Sotirov* (*Tilburg University*) about *A new perspective on mixed-integer semidefinite programming* and *Aharon Ben-Tal* (*Technion - Israel Institute of Technology*) about *An algorithm for maximizing a convex function based on its minimum and beyond*.

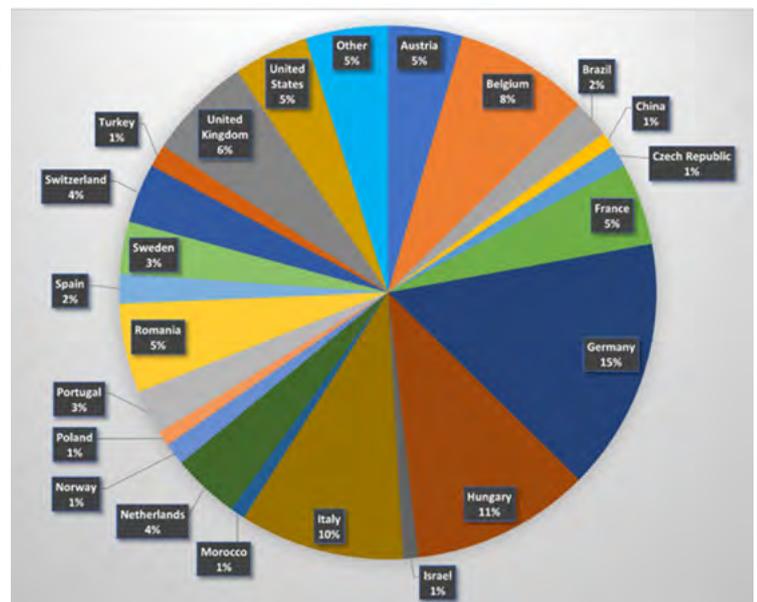
Every year, the *EUROPT* Working Group honours one outstanding researcher in continuous optimization by awarding the *EUROPT Fellowship*. The Fellowship is presented to the awarded researcher at the workshop and the Fellow delivers the *EUROPT Fellowship Lecture* as a plenary talk. The recipient of the 2023 award was *Coralia Cartis* (*Oxford University*) and she delivered her *EUROPT Fellowship Lecture* on *Tensor methods for nonconvex optimization*. Before her lecture, she addressed the audience with a moving thank-you speech and dedicated the award to the community and in particular to the youngest generation of researchers who were attending her talk and the workshop.

Social Program

EUROPT 2023 included some social events: a welcome party was held at *Corvinus University* on the evening of 22 August, after the end of the *EUROPT Summer School* that had just ended in the same location; a conference dinner took place in the city center on 24 August; a surprise “special session” to celebrate *Tibor Illés’* 60th birthday was organised by his former PhD students *Marianna* and *Petra*, and it happened immediately after the closing session ended.

Next events

The rich scientific and social programs of *EUROPT 2023* made it a great event allowing the community to get together in a nice environment to enjoy advances in continuous optimization and the beauty of Budapest.



▲ *EUROPT 2023*: participation by countries.



▲ *EUROPT* fellowship awarding: Coralia Cartis (centre), Giancarlo Bigi (left) and Sonia Cafieri (right).



▲ *EUROPT* 2023: participants group picture.

A new *EUROPT* conference is being planned for 2024 in Scandinavia in late June: information about it will be spread very soon.

In the same year a new chance to gather together and enjoy

Budapest is available as well in the same location of *EUROPT* 2023: the 10th *VOCAL Optimization Conference: Advanced Algorithms* will be held at Corvinus University of Budapest on the last week of May or the first week of June 2024, check <http://vocal.p-graph.org/> for more information. 🌍

Bringing Junior Researchers in Combinatorial Optimization together

A view on *FRICO* 2023, Eindhoven

Jasper van Doornmalen <m.j.v.doornmalen@tue.nl>

Last summer, the 26th edition of the *Future Research In Combinatorial Optimization Workshop (FRICO 2023)*, <https://www.win.tue.nl/frico2023/>, mirror <https://archive.is/j6XBc> took place at the *Eindhoven University of Technology* (<https://www.tue.nl/>), hosted by the *Combinatorial Optimization Group* (<https://spor.win.tue.nl/research/co/>) of the *Department of Mathematics and Computer Science*.



▲ *FRICO* 2023: Group photo on Thursday morning at the Eindhoven University of Technology.

The *FRICO* workshop traditionally targets junior academic researchers (mostly PhD-students) that conduct research in the field of *combinatorial optimization*. One of the founding fathers of the *FRICO* workshop, *Ulrich Pferschy* (now professor and head of department at TU Graz), once described the first edition of *FRICO* as a “relaxed exchange of events”. *FRICO* 1997 was a single-day event, but its repeated successes in the next years allowed the workshop to grow to a three-day event, and later to the full-week event that it is today. Over the years, new elements got added to the workshop, such as the inclusion of an industry day, the best-talk award, and a social event.

As is tradition by now, every participant of the workshop gives a presentation about their research. These presentations could be about finished or published work, but it is also encouraged to present partial results or ongoing work. All presentations are given in a single-stream fashion, so that everyone can attend the presentation of all others. This way, the bar of attending is kept purposefully low, shaping the approachable and friendly atmosphere as originally intended.

Maybe as a result of this, for many participants, *FRICO* is often the first workshop or conference that they visit in their journey towards a PhD degree. And, the past has shown that many participants return to *FRICO* the next year again! I believe that the goal of the workshop is to connect us academic peers in their early stage of the research career. In fact, I am aware of various now-collaborating researchers that first met as PhD-students at a past *FRICO* workshop!

Over five days from August 14 to August 18, *FRICO* 2023 hosted 39 presentations by PhD-students, three presentations by the industrial sponsors, and many moments that allow for discussions, networking and socializing with our academic peers.

Most PhD-presentations were planned on Monday and Tuesday. These were intense days, starting early in the morning at 09:30, going on until late in the afternoon at 17:30. This was followed by catered dinner and planned social events in the evening.>>

>> On Monday, we hosted a *pubquiz* while enjoying the pizzas prepared by *Hubble Community Cafe* on the campus. Surprisingly, the team that won the quiz with (by far) the most points was the team "*Team of First Timers*". We still do not know how they got almost full points in the *FRICO* history and trivia round. After two intensive days full of presentations, as of Wednesday we only scheduled PhD-presentations before the lunch. Wednesday afternoon were industry partner presentations, with presentations given by *TNG Technology Consulting*, *ORTEC* and *Siemens*. This was followed by the conference dinner at the *Wasven* biological restaurant with the industry partners.



▲ The former best talk award holder *Kirill Kukharenko* (left) handing over the best talk award to *Torben Schürenberg* (right).

participants (or organizers) got hurt during the social event.

After a final series of presentations on Friday morning, it was time to look back on the workshop. The workshop featured many excellent presentations, but only one could be elected as the best. This year, the best talk award got awarded to *Torben Schürenberg* from the University of Bremen for his presentation "*Hunting an invisible rabbit on an infinite graph in finite time.*" I think this is more than justified.

Torben's presentation featured an interesting question of combinatorial nature. Fueled with his enthusiasm, the clear semi-realistic story of hunting a bunny in a game-like fashion, and his perspicuous illustrations, I am convinced that everyone in the audience enjoyed his presentation.

Thursday afternoon was the social event, where the participants were split in smaller groups to play an escape tour through the center of Eindhoven. The story played was set in occupied Eindhoven during World War II, and the goal of the story was to find *Frits Philips*, the founder of the Eindhoven-based lightbulb factory *Philips*. Needless to say, we from the organization overlooked the potential sensitivity of this topic, especially since *FRICO* is traditionally a German workshop and most participants are from Germany too. Our fears grew stronger when the app instructed to find *Frits Philips* - and I quote - "*before the Germans find him*". Luckily none of the

FRICO 2024 takes place at the Otto von Guericke University Magdeburg. The organization likes to thank *Kirill Kukharenko* and *Sarah Feldmann* for ensuring the continuation of the *FRICO workshop!* Moreover, I would like to thank my fellow organizers *Lucy Verberk*, *Sten Wessel*, *Sjanne Zeijlemaker*, *Danny Blom*, *Hans de Ferrante*, *Dylan Hyatt-Denesik* and *Antonina Khramova*, for all efforts that we put in the organization *FRICO 2023*. 🌍

Coloring graphs in the green Ardennes - one of the challenges of the 11th GO Conference:

GO XI Conference in Spa (Belgium), July 2-6, 2023

Marino Widmer <marino.widmer@unifr.ch>

Finally, after several postponements due to the COVID 19 pandemic, the *GO XI conference* took place in Spa at the beginning of July this year.

As well as meaning 'to go forward', "*GO*" is an acronym for *Graphs and Optimization!* Indeed, this conference enables invited experts active in these exciting fields to share their most recent research results in a very relaxed working environment.

A little history: from *GO I* to ...

In 1991, *Alain Hertz* and *Marino Widmer* were looking for an original idea to celebrate the 50th birthday of their mentor and scientific father: *Dominique de Werra*. They came up with the first *GO* conference, which was held in Grimontz, a lovely village in the Valais Alps in Switzerland, from 23 to 28 August 1992. With the help of *Christian Ebenegger*, thanks to a list of invitees provided by *Dominique de Werra* and *Tom Liebling* (who was also coincidentally celebrating his 50th birthday), this first edition was a great success, "*with more than 70 participants from four continents attending a total of forty scientific communications on various aspects of graphs, combinatorics, optimization and heuristic methods*".



▲ Almost all the *GO XI* participants.

Thanks to the unfailing help of *Peter Hammer*, it has been possible to disseminate the results presented at this conference in a special issue of *Discrete Applied Mathematics*.

At more or less regular intervals, ten other conferences followed this first edition, with a novelty: each of them was organised in a location with thermal baths !

Two participants deserve to be congratulated: in addition to the two initiators of this series of conferences (*Alain Hertz* and *Marino Widmer*), *Jacek Blazewicz* and *Jacques Carlier* have taken part in the *eleven GO* conferences organized to date ! Well done to both of them !

Table 1 contains the relevant information dealing with the *eleven editions of GO*.

to **GO XI**

The 11th edition of the *GO Conference*² was organized by Bernard Fortz, Hadrien Mélot, Alain Hertz, Bernard Ries, David Schindl and Sacha Varone, in Spa (Belgium), a small village well known to spa-goers since the end of the XIXth century, current Formula 1 supporters and now experts in graphs and optimization !

Year	Name	Location	In honour of ...
1992	GO I	Grimentz (CH)	Dominique de Werra and Thomas M. Liebling
1994	GO II	Leukerbad (CH)	Nobody ! It was just a strong request from the GO I participants !
1996	GO III	Leukerbad (CH)	Claude Berge
2000	GO IV	Leukerbad (CH)	Gilbert Laporte
2006	GO V	Leukerbad (CH)	Peter L. Hammer and Jakob Krarup
2007	GO VI	Cademario (CH)	Dominique de Werra and Thomas M. Liebling
2010	GO VII	Ovronnaz (CH)	Alain Hertz, Maurice Cochand, Alain Prodon and Marino Widmer
2012	GO VIII	Leukerbad (CH)	Dominique de Werra, Vadim Lozin, Jan Weglarz and Thomas M. Liebling
2014	GO IX	Sirmione (I)	Jacques Carlier, Martin C. Golumbic and M. Grazia Speranza
2016	GO X	Rigi (CH)	Martine Labbé, Jacek Blazewicz and Pavol Hell
2023	GO XI	Spa (B)	Myriam Preissmann and Yves Crama

▲ Table 1: Eleven editions of *GO Conferences* successfully held.

This year's honorary guest speakers were Myriam Preissmann³ (Laboratoire G-SCOP, University Grenoble Alpes, France) and Yves Crama⁴(HEC – Management School, University of Liège, Belgium), two researchers well known to our scientific community.

Bioinformatics, Scheduling. According to the tradition, promising young researchers had the opportunity to submit their recent results to the critical - and always constructive - opinion of recognised experts in their field, leading to some very fruitful exchanges.

Myriam Preissmann presented the latest developments in graphs with holes ("About the structure of the graphs whose holes all have the same length"), while Yves Crama focused on the delicate problem of kidney exchange in the healthcare field ("Graph and optimization models for kidney exchanges").

Table 2 summarizes the *scientific program*⁵.



▲ Myriam Preissmann and a 9-holed pyramid.



▲ Yves Crama and kidney exchanges.

In addition to these two captivating plenary lectures offered by the two jubilarians, the scientific programme was completed by 28 very interesting contributions, presented by part of the 44 participants. The organizers have chosen to divide these talks into 6 specific *Streams*: Combinatorial Optimization, Graphs, Graph Coloring, Matching, Healthcare and

Speaker	Title
Graph 1	
Jing Huang	Strong Cocomparability Graphs and Slash-free Orderings of Matrices
David Schindl	Finding k-community structures in special graph classes
Mark Korenblit	Complexity of Algebraic Expressions Motivated by Graphs
Keynote	
Yves Crama	Graph and optimization models for kidney exchanges
Combinatorial Optimization 1	
Alain Hertz	Hypercubes for the cold start problem in recommender systems
Ignacio Pelayo	Strong locating sets in Pseudotrees
Giovanni Felici	MIP models for Simultaneous Feature Selection and Outlier Detection in Linear Regression
Combinatorial Optimization 2	
Alfredo Marin	Comparing formulations of The Ordered Travelling Salesman Problem
Jérôme De Boeck	Iterative Price-and-Branch for railway crew scheduling
Immaculada Espejo	Upgrading arcs to p-median problem in a bi-network
Graph 2	
Pierre Hauweele	A new web interface to PHOEG, a tool that Helps to Obtain Extremal Graphs
Valentin Dusollier	About a conjecture on the number of non-equivalent colorings of graphs
Gauvain Devillez	Extremal results on the Arithmetic Geometric Index
Healthcare and Bioinformatics	
Aleksandra Swiercz	Graph theory in the context of DNA de novo assembly
Marie Baratto	Local stability in kidney exchange programs
Graph 3	
Chinh Hoang	A closure lemma for tough graphs and Hamiltonian ideals
Christophe Picouleau	On the complexity of the Minimum Dominating Set in claw-free graphs with Diameter two
Martin Golumbic	The Zeroth Book of Graph Theory (An after dinner speech)
Scheduling	
Luca Brunod Indrigo	Algorithms and complexity results for resource leveling problems
Thomas Stützel	Automated Design for Permutation Flow-shop Problems
Jacques Carlier	More powerful energetic reasoning for the Cumulative Scheduling Problem
Combinatorial Optimization 3	
Michal Stern	Insertions for feasibility of clustered trees on grid intersection graphs
Hugo Callebaut	Leveraging preprocessing for optimal Segment Routing
Frits Spieksma	Stable Approximation Algorithms for a Range-Assignment Problem
Keynote	
Myriam Preissmann	About the structure of the graphs whose holes all have the same length
Graph Coloring	
Diana Sasaki	On the equitable total coloring of snarks
Felix Mann	On d-stable locally checkable problems on graphs of bounded mim-width
Kathie Cameron	Reconfiguration of Vertex Colourings and Forbidden Induced Subgraphs
Matching	
Sébastien Bonte	The average size of maximal matchings in graphs
Felicia Lucke	Matching Cuts in H-free graphs

▲ Table 2: The scientific program of *GO XI* at one glance.



▲ GO's Got Talent : the hearing of Les Galopins.



▲ Wine tasting #1.



▲ Wine tasting #2.

The social programme was not neglected by the organizers : in addition to an afternoon in the thermal baths close to the conference venue, a memorable banquet delighted all the participants, both with the food and drinks and with the entertainment prepared by several of the attendees to pay tribute to the two jubilarians !

GO XII ?

At the end of each GO conference, during the closing session, one question keeps coming up: when and where will the next GO take place ?

Only the organizers, who are all working on a volunteer basis (please do not forget it), know the answer. Let's hope they

come to a decision soon ...

The author **Marino Widmer** is professor at Université de Fribourg – DIUF, Switzerland.

¹Alain Hertz, Maurice Queyranne, Marino Widmer, First International Colloquium on Graphs and Optimization (GO I): Preface, Special Issue of Discrete Applied Mathematics, vol 65, no 1-3 (1996), pp 1-3.

²<https://mathopt.be/go2023>.

³<https://g-scop.grenoble-inp.fr/fr/laboratoire/preissmann-myriam>.

⁴https://www.uliege.be/cms/c_9054334/fr/repertoire?uid=U013053.

⁵A useful link to download the abstract booklet:

<https://www.euro-online.org/conf/admin/tmp/program-go2023.pdf> 🌐

ICEMP 2023 in Kuala Lumpur, Malaysia, Investigating Engineering Mathematics and Physics by OR: “Mathematics is the mirror of civilization”

Cristinca Fulga <fulga@csie.ase.ro>



The 12th International Conference on Engineering Mathematics and Physics (ICEMP 2023) was held in Kuala Lumpur, Malaysia on July 5-7, 2023 (<http://www.icemp.org/>). The past 11 ICEMP conferences were held in Ningbo (China), Bangalore (India), Colombo (Sri Lanka), Hong Kong, Kuala Lumpur (Malaysia), and Dubai (UAE), Cape Town (South Africa), Prague (Czech Republic), Istanbul (Turkey), Barcelona (Spain), Saint-Etienne (France). ICEMP 2023 resumed the in-person format after the last three years of virtual format in 2020, 2021, and 2022.

Year after year, this annual research conference serves as a meeting platform, bringing together researchers from around the world coming from both industry and academia, having a common interest in Engineering Mathematics and Physics. The theme of ICEMP 2023 conference was “Mathematics is the mirror of civilization” so, as expected, the field of Operational Research (OR) was very well represented. Certainly, OR plays a significant role in the realm of Engineering Mathematics by providing essential tools and methodologies for solving complex real-world engineering problems. It serves as

a bridge between mathematical theory and practical applications, helping engineers use mathematical models, optimization techniques, and statistical methods to tackle a wide range of challenges. Whether it's optimizing the design of structural components, managing complex supply chains, or scheduling production processes, OR allows engineers to make data-driven decisions and find the best solutions. It enhances the efficiency, cost-effectiveness, and overall performance of engineering systems, making it an invaluable part of Engineering Mathematics that ensures the application of mathematical concepts to address the intricacies of real-world engineering problems. Thus, the theme of ICEMP 2023, “Mathematics is the mirror of civilization”, was reflected in a wide range of topics, from Mathematical Methods in Sciences and Engineering - applications of OR, optimization theory and methods, mathematical models in economy, insurance and medicine, mathematical models for the information society - to Nuclear Physics Theory and Experiment, and Physics of Complex Systems & Biophysics.



▲ Ibis Kuala Lumpur City Centre impacted ICEMP 2023 participant satisfaction.

The conference was a three-day event, with 39 presentations. The *Opening* and *Keynote* presentations were chaired by Prof. Haydar Akca, Abu Dhabi University, UAE. The *keynote presentations* were delivered by the following distinguished speakers:

- o Prof. Lazim Abdullah, Faculty of Ocean Engineering Technology and Informatics, University Malaysia Terengganu: "Developing interval type-2 fuzzy moving average control charts",
- o Prof. Kok Lay Teo, Curtin University; Australia, School of Mathematical Sciences, Sunway University, Malaysia: "Optimal Control Computation for Nonlinear Switched Systems",
- o Prof. Liu Mei Feng, Xiamen University Malaysia: "Mathematical Modelling for the Fully Coupled Thermo-Magneto-Electro-Elastic (TMEE) Laminate Based on Entropy and Heat Equations",
- o Prof. Peter Chew, National University of Malaysia: "Education 4.0 Calculator Learning Method",
- o Prof. Xiaojun Yang, State Key Laboratory for Geomechanics and Deep Underground Engineering, China University of Mining and Technology; King Abdulaziz University, Jeddah, Saudi Arabia; Kyung Hee University, Seoul, Republic of Korea: "A New Challenge in the Field of Mathematics",
- o Prof. Lukasz T. Stepien, The Pedagogical University of Cracow, Poland: "On some exact solutions of the SDYM equations",
- o Prof. Hesham Elkaranshawy, Alexandria University, Egypt: "A Mathematical Model for Cardiac Induction System".

Conference papers were submitted and evaluated by double-blind reviews. Accepted and registered full papers will be collected in Journal of Physics: Conference Series (doi:10.1088/issn.1742-6596; Online ISSN: 1742-6596 / Print ISSN: 1742-6588), indexed by Conference Proceedings Citation Index – Science (CPCI-S), Scopus, Ei Compendex, Inspec (IET).

The conference venue was the hotel *Ibis Kuala Lumpur City Centre* which has been instrumental in the success of the *ICEMP 2023* conference (see <http://www.icemp.org/venue.html>). Its convenient location, well-equipped facilities, accommodating capacity, and appealing ambiance have enhanced accessibility and participant satisfaction. The hotel services and amenities, along with its reputation, have positively influenced the conference image, attracting attendees and contributing to a smooth and engaging event. The nearby amenities further improved the overall conference experience, making the hotel a significant factor in the conference's success.



▲ Well-equipped facilities and ambiance enhanced the ICEMP 2023 conference experience.

ICEMP 2023 conference was sponsored by the *University of Malaya*, *University Malaysia Terengganu*, *Abu Dhabi University*, and also *Media Partner*, *i-Conference Global*, *Wiki CFP*, *Academinc.Net*, and *WeChat*, and it was a great success: The insight gained and connections made between the participants to *ICEMP 2023* will continue to show their benefits in the future. Organizers hope to see you at *ICEMP 2024!* 🌍

7th ICO-2023 Phnom Penh in wonderful Cambodia - OR Inspiration, Insight and Wisdom

Pandian Vasant <pvasant@gmail.com>, **Alexander Fominyh** <alexfomster@mail.ru>, **Rolly Intan** <rintan@petra.ac.id>, **Jose Antonio Marmolejo-Saucedo** <jose.marmolejo@fi.unam.edu>, **Joshua Thomas** <joshua.j.thomas@gmail.com>, **Gerhard-Wilhelm Weber** <gerhard.weber@put.poznan.pl>

The 7th edition of the *International Conference on Intelligent Computing and Optimization, ICO 2023*, was held during October 26-27, 2023, at Baitong Hotel & Resort, Phnom Penh, Cambodia. The objective of the international conference is to bring the international research scholars, experts and scientist in the research areas of *Intelligent Computing, Optimization and Operational Research* from all over the world to share their knowledge, expertise and experiences on the current research achievements in these fields.

The opening ceremony was started with *Dr. Pandian Vasant (Chair)* and continued with the presentation of the papers by the conference participants. The following are some of the aspiring activities took place on the 1st and 2nd conference day at Baitong Hotel & Resort, Phnom Penh.

About 40 attendees attended the wonderful gala of this two-day on-site event *ICO 2023* at Baitong Hotel & Resort, Phnom Penh, Cambodia. With great interest and care the Session Chairs carried out their duties great enthusiasm while participants presented their papers with great passion. The young researches from across the globe gave their level best to exhibit and advance their skills and talents in presenting novel results and findings. The Q&A sessions went on very well during the 2 days. The organizing committee would like to sincerely thank *Prof. Dr. Karl Andersson* (Luleå University of Technology, Sweden) and *Prof. Dr. Mohammad Shahadat Hossain* (University of Chittagong, Bangladesh) for their marvelous contribution to 7th *ICO-2023* Phnom Penh, Cambodia). >>



▲ Dr. Pandian Vasant awarding Certificate of Appreciation to Dr. Kanak Kalita (Keynote Speaker, India).



▲ Dr. Agus Suharyanto (Universitas Brawijaya, Indonesia) delivering "Affected of Climate Change to Runoff Discharge".



▲ Alyssa Patricia Ocampo (Polytechnic University of the Philippines) receiving the Best Presenter certificate of appreciation for "3D Printing in the Philippines: Adoption, Impact, and Applications" from Dr. Agus Suharyanto (Indonesia).



▲ Dr. Tham Vo (Nguyen Tat Thanh University, Vietnam) receiving the Best Contributor Certificate of appreciation and token of gift from Dr. Alexander Fominyh (Saint Petersburg State University, Russia).



▲ Neesha Rajkarnikar (Pokhara University, Nepal) receiving the Best Paper certificate of appreciation from Prof. Dr. Rolly Intan (Petra Christian University, Indonesia).



▲ Participants from the Closing Ceremony at Baitong Hotel Resort, Phnom Penh.



▲ Participants from Cambodia, Russia, Vietnam and The Philippines having a good time at a Tea Break Session.



▲ Delegates from Vietnam and The Philippines enjoying their happy moment at the Gala Buffet Dinner in Kuang Seafood, Baitong Hotel & Resort, Phnom Penh.

All the papers were successfully presented by the authors. The 8th ICO Conference will be held *on-site* on 30-31 May 2024 at *Sheraton Surabaya Hotel & Towers, Surabaya, Indonesia*; authors can submit their full papers via SpringerNature's online conference service (OCS).

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The 96th Meeting of the EWG on Multicriteria Decision Aiding Successfully held in Paris

Panos Xidonas <Panos.XIDONAS@essca.fr>

On September 21-23, 2023, at ESSCA School of Management, Paris, France, the 96th Meeting of the EURO Working Group on Multicriteria Decision Aiding (<https://mcda96.sciencesconf.org>) was a great success in terms of organization and participation. The main theme of the 96th meeting of the EURO WG on Multiple Criteria Decision Aiding (EWG-MCDA 95) aimed at studying the application of multiple criteria decision aiding methods in climate, technology and finance.

More than 60 papers of high-quality submitted to the conference, with co-authors from 22 countries. Also, 80 scientists of very high academic background took part in MCDA-96. During the conference, Jean Charroin, ESSCA Dean & CEO, offered an *honorary plaque* award to Prof. Roman Slowinski from Poznan University of Technology, Poland, for his long-term contribution in the field of MCDA.



▲ Group Picture from the 96th EWG-MCDA meeting.

At the beginning of the conference, the *Bernard Roy Award* was given to Prof. Lefteris Siskos, for his contributions to MCDA, as a young scientist below 40 years old.

Also, the conference hosted 2 keynote speeches. The first speech was delivered by Prof. Ralph E. Steuer, the Sanford Family Distinguished Chair of Business in the Department of Finance of the Terry College of Business at the University of Georgia. The title of his speech was: “On the Differences between Tri-Criterion & Bi-Criterion Portfolio Selection in Graphs”.

The second speech was delivered by Prof. Evangelos Triantaphyllou, Full Professor at Louisiana State University, School of Electrical Engineering & Computer Science and Adjunct Associate Professor at Tulane University, School of Medicine. The title of his speech was: “Towards an intelligent MCDA approach for dealing with today’s complex problems”.

During the meeting were introduced various contributions on both the theoretical and practical foundations of MCDA, decision support tools, MCDA applications in climate, technology and finance, etc.

Finally, a Special Issue in the *Annals of Operations Research* of Springer will accommodate selected papers presented in the conference. 🌍



▲ Opening Ceremony of the 96th EWG-MCDA meeting, with the awarding of the plaque of honor to Prof. Roman Slowinski (right), from Jean Charroin, ESSCA Dean & CEO.



▲ Lefteris Siskos (left), the recipient of the Bernard Roy Award, and Panos Xidonas on behalf of the Organizing Committee.

41st MME: Mathematical Methods in Economics and OR, held in 2023 in the beautiful city of Prague

Petra Zýková <petra.zykova@vse.cz>, Josef Jablonský <jablons@vse.cz>

The *Mathematical Methods in Economics (MME)* conference has a very long history and tradition. It is one of the most important scientific events organised in the Czech Republic in the fields of operational research (OR), econometrics, mathematical economics, and related research areas. In 2023, the 41st International Conference on Mathematical Methods in Economics was organised in the “Golden City” of Prague from 13th to 15th September. In addition to the local organiser (the Department of Econometrics, Faculty of Informatics and Statistics, Prague University of Economics and Business), the main leading organiser of the MME conference was the *Czech*

Society for Operations Research (CSOR). The conference took place at the *Prague University of Economics and Business*, which is the top Czech university that provides economic education. The university has excellent facilities for organization of such scientific event. By the way, the university hosted a very successful *EURO Conference in 2007* with more than 2000 participants worldwide.

The total number of participants in this year’s *MME* conference was more than 110. Participants came from the Czech Republic, Slovakia, Lithuania, Belgium, Spain, Turkey, Greece and the Great Britain. >>

>> The programme started with an opening ceremony, where the Chair of the Organising Committee, *Josef Jablonský*, introduced the main programme and all the facilities. After that, the plenary session started with two exciting lectures. The first one, titled “*Network Data Envelopment Analysis: “The Prevalent Methodological Approaches and Some Recent Developments”*”, was presented by *Professor Dimitris Despotis* from the University of Piraeus, Greece. *Professor Miloš Kopa* from Charles University, Faculty of Mathematics and Physics, Prague, delivered the second plenary talk about “*Decision Making in Finance via Stochastic Dominance*”. After the plenary session, the conference was divided into four parallel sessions. The total number of presentations was almost 90. All accepted papers are published in the *Proceedings of the MME 2023*. As in previous years, they have been submitted for indexing in the Web of Science and Scopus database. All accepted abstracts are published in the *Book of Abstracts of the MME 2023*.



▲ Opening Ceremony of MME 2023 (left to right): *Assoc. Prof. Miloš Kopa* (Charles University), *Prof. Dimitris K. Despotis* (University of Piraeus), *Prof. Josef Jablonský* and *Prof. Jakub Fischer* (both Prague University of Economics and Business).



▲ MME 2023: Doctoral students with awards from competition with *Prof. Helena Brožová* (first person) and *Prof. Josef Jablonský* (third person).

It has been a long tradition for PhD students to compete for the best paper during MME conferences. The competition is organised and honoured by the CSOR. All submitted papers were peer-reviewed, and the programme committee further evaluated the papers with positive referee reports. Ten best-selected papers were presented at the conference in

two special sessions, and the evaluation committee decided on the winners. The six best papers were awarded after a conference dinner in the restaurant *Červený Jelen*. The conference was organised at a great level. All sessions took place in the New Building of the Prague University of Economics and Business. The welcome evening took place in the Academic Club Restaurant which is located on the top floor of the Paradise Building of the Prague University of Economics and Business. An essential part of all conferences is a social programme that offers many opportunities to discuss various problems in an informal environment. The organisers have prepared three trips: Most participants took part in a guided tour of *Konopiště Castle*. The second trip was a hiking excursion to *Tetín*, and the third trip was a *Puzzle hunt* in Prague. The conference dinner took place in the restaurant *Červený Jelen* on Hybernská Street. This year’s annual meeting of the CSOR decided that the 42nd MME conference will be organised in the city of *Ústí na Labem*, Czech Republic, at *Jan Evangelista Purkyně University*, the Faculty of Science, the Department of Informatics, from 11th to 13th September 2024. The conference website is available at <https://mme2024.ujep.cz/>. 🌐

MOPTA 2023 @ Lehigh U. in Bethlehem, PA, USA: From Geo and Data Sciences Through Health and Humanitarian Logistics to Quantum Computing – Modeling and Optimization is Everywhere!

Tommaso Giovannelli <tog220@lehigh.edu>, **Tamás Terlaky** <terlaky@lehigh.edu>

The *Modeling and Optimization: Theory and Applications (MOPTA) Conference* is an annual conference hosted by the Industrial and System Engineering Department at Lehigh University. The 23rd edition of MOPTA took place at Rauch Business Center, Bethlehem, PA (USA) from August 16 through August 18, 2023. MOPTA 2023 welcomed approximately 140 participants to the Lehigh campus. The program of the conference consisted of 7 plenary talks from leaders in the field, 32 parallel sessions, a poster competition, and the 15th AIMMS-MOPTA Optimization Modeling Competition. The talks covered a wide spectrum of topics, ranging from data science and machine learning to quantum computing and applied operations research. In addition to the scientific program, participants had the opportunity to network and build

new connections during the student social and conference banquet. More information about the conference can be found at this link: <https://coral.ise.lehigh.edu/~mopta>

MOPTA conferences aim at bringing together a diverse group of people from both discrete and continuous optimization, working on both theoretical and applied aspects. The format consists of invited talks from distinguished speakers and selected contributed talks, spread over three days. The goal is to present a diverse set of exciting new developments from different optimization areas while at the same time providing a setting that allows increased interaction among the participants.

>> MOPTA started in 2000 as a one-day workshop and has grown into an exciting three-day conference. Founded by Lehigh ISE faculty member *Tamás Terlaky*, MOPTA has been organized and hosted by the Lehigh ISE Department since 2009. In 2022, MOPTA was jointly held with ICCOPT 2022, which welcomed approximately 600 participants from around 30 countries, resulting in one of the largest, if not the largest, academic events ever held on Lehigh's campus.

Led by *Luis Nunes Vicente* since 2018, the Lehigh ISE Department provides most of the financial and administrative support for MOPTA, amongst various other sponsors (such as SAS, AIMMS, and Gurobi). MOPTA 2023 was chaired by Lehigh ISE postdoctoral researcher and adjunct faculty member *Tommaso Giovannelli*. The optimization modeling competition was chaired by Lehigh ISE faculty member *Xiu Yang*. At the conference, *Stephen P. DeWeerth*, Lehigh's Dean of Engineering, and *Nathan Urban*, the Lehigh Provost, addressed MOPTA attendees with heartfelt speeches about the significance of optimization at Lehigh University and its pivotal role for the years ahead.



▲ *Tamás Terlaky, Stephen P. DeWeerth, and Tommaso Giovannelli* welcoming MOPTA attendees during the opening session.

presented a poster titled “Moving anchor accelerated algorithms for smooth minimax problems”.

The 15th AIMMS-MOPTA Optimization Modeling Competition has been a result of cooperation between AIMMS and the organizers of the MOPTA conference. Thirteen teams of three graduate students from seven countries around the world registered for the competition and solved a challenging problem regarding the planning of electric vehicle charging stations. The teams had to form a mathematical model of the problem, implement it in AIMMS, solve it, create a graphical user interface, and write a 15-page report on the project. Three finalists were selected by a panel of judges composed of *Xiu Yang* and *Tommaso Giovannelli* from Lehigh University

and *Gabriela Servidone* from AIMMS. On Thursday, August 17, 2023, these finalists had to present their work to the panel of judges and answer judges' questions. The final ranking was announced at the Conference Banquet: 1. Team “OptiCoffee” from Universidad de Los Andes, Colombia (Team Members: *Ariel Rojas* and *Juan Betancourt*, Adviser: *Daniel Yamín*); 2. Team “Vultures” from Vrije Universiteit Amsterdam, Netherlands (Team Members: *Fergus Hathorn* and *Iker Olarra Maldonado*, Adviser: *Alessandro Zocca*); 3. Team “Clean Air Avengers” from University of Bern, Switzerland (Team Member: *Nicklas Klein*, Adviser: *Norbert Trautmann*). The first prize consisted of \$1200 plus a full scholarship, not including travel, for the AIMMS Campus 2024 event. >>



▲ Lehigh Provost *Nathan Urban* addressing MOPTA 2023 attendees

The 7 plenary talks were given by *Omar Ghattas* (The University of Texas at Austin), *Wotao Yin* (Alibaba Group US), *Laura Albert* (University of Wisconsin-Madison), *Xiaodi Wu* (University of Maryland), *Fatma Kılınç Karzan* (Carnegie Mellon University), *Stefanie Jegelka* (MIT), and *Julie Ivy* (North Carolina State University). The poster session and competition were held on Wednesday, August 16, 2023. All 8 posters presented in the poster session entered the poster competition automatically. Three posters were selected as finalists of the competition by a panel of judges composed of *Albert S. Berahas* from University of Michigan (chair), *Sadan Kulturel-Konak* from Pennsylvania State University, Berks, and *Javier Peña* from Carnegie Mellon University. The winner, announced at the conference banquet, was *Caleb Ju* from Georgia Tech, who presented a poster titled “Dual dynamic programming for stochastic programs over an infinite horizon”. The other finalists were *Brendan Ruskey* from Lehigh University who presented a poster titled “A new multiobjective heuristic for creating political redistricting plans while maximizing similarity to a previously-used plan”, and *James Alcalá* from the University of California, Riverside, who



▲ Poster Session and Competition.



▲ *Julie Ivy* delivering the *Schantz ISE-COH-HSE* lecture.

>> The second-place and third-place teams received \$600 and \$300, respectively. In addition, the 10 best teams that used AIMMS as the software platform for their submissions were awarded \$100 in prize money. As usual, the *AIMMS-MOPTA Optimization Modeling Competition* proved to be a thrilling and integral part of *MOPTA*.

The conference concluded with the plenary session delivered by *Julie Ivy*, an integral part of the prestigious *Schantz ISE-COH-HSE* lecture series. This series is jointly organized by Lehigh ISE, the College of Health, and the HSE Program. The title of the lecture was *"Learning from Data for Decision Making in Health and Humanitarian Logistics: Insights and Challenges in a World with Increasing AI"*. During the closing session, *T. Terlaky* encouraged participants to attend *MOPTA 2024* and unveiled plans for a special edition of *MOPTA* in 2025, coinciding with the 25th anniversary of its inception. 🌍



▲ Team "OptiCoffee", winner of the 15th AIMMS-MOPTA Optimization Modeling Competition

M-PREF 2023: 14th Multidisciplinary Workshop on Advances in Preference Handling - A vivid workshop held in Macao, S.A.R., between two former islands

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Human-centered computing in artificial intelligence and other computational fields needs to take human preferences into account in order to produce satisfactory results. Examples are recommender systems, chatbots, travel planners. The *multidisciplinary workshop on advances in preference handling* permits researchers and practitioners to discuss questions posed by these new application areas for preferences and to explore computational methods for learning, representing, aggregating, and exploiting preferences. The workshop series has been incubated at a Dagstuhl seminar in 2004 and since held in alternation with the conference on *Algorithmic Decision Theory*. Its organization is coordinated by the *EURO Working Group on Preference Handling*.



▲ The M-PREF 2023 participants.

The fourteenth event in this series has been held in Macao S.A.R. on August 21, 2023, as part of the *IJCAI 2023* workshop program. The organizers have been *Haris Aziz*, *Ulrich Junker*, and *Xinhang Lu*, who have animated the workshop on site, as well as *Nicholas Mattei* and *Andrea Passerini*. The workshop was very well attended (30 participants with a peak of 40 during the panel) and offered an interesting program to the audience.

The highlights of the workshop consisted of two invited talks and a panel discussion, all related to computational social choice. *Warut Suksompong* (National University of Singapore, Singapore) was the first invited speaker and presented results about *"Weighted Fair Division: Additive Preferences and Beyond"*. *Warut* considered fair allocation of goods to multiple parties where certain parties have more weights than others. For example, the weight may correspond to the number of party members. He generalized well-known fairness notions

such as envy-freeness and proportionality to this weighted setting. He used picking sequences to solve special cases of weighted fair division and studied fairness guarantees of those sequences. These guarantees can be given for additive and even for submodular valuations, but the question is open for subadditive and supermodular valuations. *Warut* also studied welfarist rules and showed that they exhibit attractive properties under matroid-rank valuations. His conclusion was that weighted fair division is often richer and more challenging than its unweighted counterpart.



▲ M-PREF 2023: The conference location in Cotai, Macao.



▲ M-PREF 2023: Warut Suksompong giving the first invited talk.



▲ M-PREF 2023: Panel participants from left to right: Lirong Xia (remote), Toby Walsh, and Nisarg Shah.



▲ M-PREF 2023: Piotr Faliszewski giving the second invited talk.

The second invited talk has been given by *Piotr Faliszewski* (AGH University of Science and Technology, Krakow, Poland) on “*Method of Equal Shares for Participatory Budgeting in Practice*”. In participatory budgeting, citizens are voting for one or more municipal projects they would like to finance. A voting rule then chooses a subset of projects while respecting the total budget. *Piotr* analyzed the real-world outcomes of the standard method (greedy approval voting) for multiple cities and found that the allocations are not fair to all groups of voters. More expensive projects may be funded even if they have less support. *Piotr* advocated a fairer voting rule: each voter gets an equal share of the budget and voters need to pay a part of this budget when their projects get selected. This method of equal shares decreases the share of voters without funded projects in the considered cases.

We then had a panel discussion on “*Fairness: From Social Choice to Machine Learning*” that was moderated by *Toby Walsh* (UNSW

Sydney, Australia) and had *Nisarg Shah* (University of Toronto, Canada) and *Lirong Xia* (Rensselaer Polytechnic Institute, USA) as panelists. The panel started with two short presentations by the panelists about their recent research at the interface between fairness, social choice and machine learning. More specifically, *Nisarg Shah* talked about how preference-based notions of fairness are aptly suited for a wide range of modern decision-making systems. In the meantime, he also shared his view on what principles make a fairness notion good. *Lirong Xia* talked about why we care about “*AI-powered Group Decision Making*” and how to make it work. In the past, we have already seen two-way connections between social choice and machine learning such as learning desiderata, beyond worst-case evaluation, fairness of machine learning classifiers, etc. We then moved on to follow-up audience-driven questions and discussions, revolving around the two presentations as well as the theme topic in general.

The workshop also included five paper presentations, namely two on computational social choice, two on preference learning, and one on multi-criteria decision making. *Jeremy Vollen* (UNSW Sydney, Australia) presented joint work with *Haris Aziz*, *Xinhang Lu*, *Mashbat Suzuki*, and *Toby Walsh* on achieving both ex-ante fairness and ex-post fairness in committee voting. Ex-ante fairness imposes lower bounds on the expected utility of individual voters or groups of voters. Ex-post fairness ensures that all cohesive voter groups of a certain size get a certain number of candidates approved. *Xinhang Lu* (UNSW Sydney, Australia) examined approval voting with both divisible and indivisible goods and generalized results from multi-winner voting and cake sharing to this combined setting.

Paul Weng (Shanghai Jiao Tong University, China), in a joint work with *Guanbao Yu* and *Umer Siddique*, considered deep reinforcement learning with multiple objectives and developed a social welfare function that extends Lorenz dominance to a total order. *Margot Herin* (LIP6 - Sorbonne University, France) presented new results on learning compact preference representation based on the Choquet Integral. *David Xuejun Wang* (Morningstar, Inc., USA), in a collaboration with *Yong Zheng*, explored different ways to relax Pareto dominance in multi-criteria decision making in order to rank the given alternatives.

As closing remarks, *Ulrich Junker* gave a short history of the *M-PREF workshop series*. He explained its original motivations and argued that they remain valid in “the age of machine learning”.

The audience has much appreciated this year’s workshop and has, in particular, been impressed by the quality of the invited talks and the panel discussion.

The detailed program can be found on the workshop website <https://sites.google.com/view/m-pref-2023/home>.

For more information about future events on preference handling, please consult the web site of the *EWG on preference handling* <https://www.euro-online.org/web/ewg/31/euro-working-group-on-preference-handling> or subscribe to the newsletter via <http://preferencehandling.free.fr/wg/>. 🌐

ODS 2023 - LI Annual Meeting of AIRO: Optimization and Decision Science, successfully researched in beautiful Ischia, Naples, Italy

Paola Festa <paola.festa@unina.it>

At the request of various colleagues and scholars of the international scientific community, the conference *ODS 2023 - International Conference on Optimization and Decision Science*, by AIRO, the Italian Operations Research Society - took place from 4 to 7 September 2023 at the Hotel Continental Terme in *Ischia* (Naples, Italy), under the direction of Paola Festa, Full Professor in *Operations Research* at the *University of Naples FEDERICO II*.

The conference has seen the participation of more than 300 scholars from America and Europe, as well as Italians. Although the main theme of the *ODS 2023* conference was "*Optimization in Green Sustainability and Ecological Transition*".

Contributions were presented at the conference on several other topics, including: Artificial Intelligence, Big Data Analytics and Optimization, Business Analytics, Continuous Optimization, Control Theory and System Dynamics, Covering and Location, Cutting and Packing, Data Mining and Classification, Decision Support Systems, Disaster Management, Discrete and Combinatorial Optimization, Emergency and Humanitarian Logistics, Energy, Environment, and Natural Resources, Financial Modeling and Risk Management, Game Theory, Global Optimization, Graph Theory and Network Optimization, Health Care and Outbreak Management, Heuristics and Metaheuristics, Linear and Nonlinear Programming, Logistics, Machine Learning, Multiple-Criteria Decision Making, OR Teaching, Railway and Air Traffic Problems, Routing Scheduling and Timetabling, Simulation and Queuing Theory, Social Network, Soft OR, Stochastic and Robust Optimization, Supply Chain Management, Traffic and Transportation.

Below are the indications of the Scientific Program Committee, the Local Organizing Committee and the names of three well-known scholars from various countries who accepted the invitation to give talks during the various sessions.

Scientific Program Committee:

Paola Festa (University of Naples Federico II) (Chair), Alessandro Agnetis (University of Siena), Edoardo Amaldi (Polytechnic of Milan), Daniela Ambrosino (University of Genova), Claudia Archetti (University of Brescia), Maurizio Bruglieri (Polytechnic of Milan), Valentina Cacchiani (University of Bologna), Francesco Carrabs (University of Salerno), Bülent Çatay (Sabancı University), Raffaele Cerulli (University of Salerno), Patrizia Daniele (University of Catania), Mauro Dell'Amico (University of Modena and Reggio Emilia), Paolo Detti (University of Siena), Luigi Di Puglia Pugliese (ICAR-CNR), Giovanni Felici (CNR-IASI), Daniele Ferone (University of Naples Federico II), Carlo Filippi (University of Brescia), Manlio Gaudioso (University of Calabria), Francesca Guerriero (University of Calabria), Stefano Lucidi (University of Rome "La Sapienza"), Giusy Macrina (University of Calabria),



▲ Gulf of Naples, Italy.



▲ A beach of Ischia, Naples, Italy.

Carlo Meloni (University of Rome "La Sapienza"), Valentina Morandi (University of Brescia), Dario Pacciarelli (University of Rome Tre), Laura Palagi (University of Rome "La Sapienza"), Panos Pardalos (University of Florida), Tommaso Pastore (University of Naples Federico II), Ornella Pisacane (Polytechnic University of Marche), Maurício Resende (Amazon), Anna Sciomachen (University of Genova), Maria Grazia Scutellà (University of Pisa), Antonio Sforza (University of Naples Federico II), Maria Grazia Speranza (University of Brescia), Claudio Sterle (University of Naples Federico II), Paolo Ventura (CNR-IASI), Daniele Vigo (University of Bologna).

Local Organizing Committee:

Paola Festa (Chair) (University of Naples Federico II), Maurizio Bruglieri (Polytechnic of Milan), Raffaele Cerulli (University of Salerno), Ciriaco D'Ambrosio (University of Salerno), Daniele Ferone (University of Naples Federico II), Giusy Macrina (University of Calabria), Tommaso Pastore (University of Naples Federico II), Ornella Pisacane (Polytechnic University of Marche).

Invited Speakers:



Prof. Claudia Archetti (ESSEC Business School, France).

Title of her talk: "*A bilevel approach for compensation and routing decisions in last-mile delivery*".



Prof. Mathijs de Weerd (TU Delft, Netherlands).

Title of his talk: "*Hybrid algorithms for train shunting and servicing at railway hubs*".



Dr. Michela Spagnuolo (Institute of Applied Mathematics and Information Technologies (IMATI - CNR).

Title of her talk: "*The Role of Geometry in Intelligent Cities of Tomorrow*".

Invited talks were also given by scholars from various national and international scientific institutions.

The initiative was adequately publicized through the most consulted electronic magazines in the sector and via news of the main scientific portals. A special website has also been set up for registering and sending scientific contributions according to pre-established formats (<http://www.airoconference.it/ods2023/>). 🌐

Experts Advocate Economic Recovery, Sustainable Development and OR as Solution to Economic Crisis: IORMS 2023 in Lagos and Online

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The 4th International Conference of the Institute of Operational Research and Management Science of Nigeria (IORMS) took place from 5th to 8th September 2023 at the Main Auditorium of the Lagos State University of Science and Technology (LASUSTECH), Ikorodu, Lagos, Nigeria. The theme of the conference was “OR: The Science of Economic Recovery, Sustainability and Control”. Professors, practitioners, researchers, and students gathered from around the world and from different parts of Nigeria to attend, analyze, and discuss the theme of the conference. The Chief Host who doubled as the Vice-Chancellor (VC) of LASUSTECH, Prof. Olumuyiwa Odusanya called for collective efforts from scholars and practitioners to address various aspects of economic development, recovery, and management.

Prof. Odusanya said apart from rapid technological changes, Nigeria like many other nations faces economic challenges amidst economic constraints in post COVID-19 era. He said it is essential to apply the theory and principle of Operational Research to solving complex societal issues and collective action to stimulate production, ensure optimal allocation of resources, maintain economic growth, and help government, organizations, and individuals to thrive. The VC stated that OR is problem-solving which involves the application of systematic methods to deal with identified problems that will enhance effectiveness, efficiency, innovation, and better results.

Earlier, the President of the IORMS, Prof. Rasheed Ojikutu, represented by the IORMS 1st Vice President, Prof. Olumuyiwa Asaolu of the Department of Systems Engineering, University of Lagos, in his welcome address said IORMS has gathered both local and foreign experts and practitioners from academia and industries to brainstorm on using OR techniques and other analytical tools to improve the system, decision-making process and the economy.

On his part, the Chairman of the Local Organizing Committee, Dr. Olabode Adewoye, while welcoming participants expressed appreciation to LASUSTECH Management for being part of the conference sponsors. He narrated the support and hospitality rendered by both LOC members of LASUSTECH and the management team. He was specifically grateful to the Vice Chancellor, the Deputy Vice Chancellor for all the support. He equally thanked the National Organizing Committee (NOC). Finally, he enjoined participants to enjoy the serene environment, the hospitality, the tea break, the lunchtime, the welcome reception, and the gala night which were designed for networking and socializing. He further stated that great scientific sessions have been prepared for the



▲ Inductees at IORMS conference 2023 taking oath.

participants to the end that Nigeria will experience humane flourishing as a result of outcomes from the IORMS Conference 2023 and since OR is the Science of System Improvement (SIS), he assured the audience to expect system improvement in Nigeria.

The students of the DIAGOLD Schools Cultural Troupe entertained the participants with cultural dance and songs to the amusement of participants. Group photographs followed immediately.

The four-day event which was designed as a hybrid, had a Keynote Speaker, four Plenary Speakers, six Goodwill messages, 25 Presenters, and over 500 participants at the opening ceremony. For the full scientific program and book of abstracts see the conference website: www.iorms.org.ng.

The Keynote Speaker, Prof. Nina Kajiji of the Computer Science/Statistics Department, University of Rhode Island, USA, delivered a paper on “National Health Care for Economic Development: Using Machine Learning to Explain Confounding Diseases States”. The first plenary speaker was Prof. Gerhard-Wilhelm Weber of Poznan University of Technology, Poland, who made two presentations on the second and third days

of the conference. The first being, “Optimal Management of defined contribution pension funds under the Effect of Inflation, Mortality, and Uncertainty” while the second was “Kerkeness Eco-Center Project in Anatolia and Future Chances by OR”.

The third day, September 7, 2023, witnessed an additional three plenary sessions. Prof. Erna Nababan, data science & AI expert from Universitas Sumatera Utara, Indonesia,

made her presentation on “Virtual Reality as Education Media for Cultural Heritage” while the paper titled, “The Efficiency of Local Government Units in Northwestern Philippines as to the Attainment of the Sustainable Development Goals” was presented by Prof. Milagros Baldemor, former dean of Graduate School, DIMMMSU Philippines. >>



▲ Profs. Ogunwolu, Olumuyiwa, Bolajoko, Adamu and Sunday (left to right).



▲ Center in white, the DVC (Acad.), and some LASUSTECH members.

>> The Guest Speaker who also doubled as one of the plenary speakers, *Prof. Sunday Omosigho* of the Department of Mathematics, University of Benin, Nigeria, analyzed and proffered ways for economic recovery, sustainability, and control by way of best Foreign Direct Investment (FDI) applications.

Other key members of *IORMS* played different roles in the success of the conference. They included *Prof. Olumuyiwa Asaolu*, professor of Systems Engineering, *Prof. Bolajoko Dixon-Ogbechi*, head of the Business Administration University of Lagos and Institute's Treasurer, *Prof. Mumuni Adamu*, head of the Statistics Department, University of Lagos, *Prof. Folorunso Ogunwolu* of Systems Engineering Department, University of Lagos, *Moses Okesola*, *IORMS* registrar, and *Gbenga Oso*, the *IORMS* Southwest coordinator.



▲ Cross section of participants at *IORMS* 2023.

Also, positive contributions that saw the successful hosting of

2023 PSAI Annual Conference: OR Solutions to Developing Countries' Concerns

Milagros R. Baldemor <milagros_baldemor@yahoo.com.ph>

The 2023 *Philippine Statistical Association, Inc.* or *PSAI* (<https://www.psal.ph>) *Annual Conference* was held at the Subic Bay Travelers Hotel, Subic Bay, Zambales, Philippines, last August 22-24, 2023, with the theme "Statistics and Digital Transformation for Better Societies". This theme is in consonance with one of the objectives of the Philippine Development Plan 2023-2028 with regard to *Artificial Intelligence (AI)*. In particular, the conference explored an avenue through *Operational Research (OR)* as a methodology to solution developing country problems.

The kickoff activity was a one-day training composed of four *Modules: Leveraging ArcGIS for Data Sharing and Collaboration; Data Analytics for Digital Transformation; Data Visualization and Storytelling; and Introduction to Cloud-sourcing Data from*

the conference came from the host community of *LASUSTECH* ably led by the *Vice-Chancellor, Prof. Olumuyiwa Odusanya*, the *DVC (Academics), Prof. Abiodun Denloye*, the *DVC (Administration), the University Registrar*. Others were the dean of the College of Applied Sciences, the dean of the College of Social Sciences, the dean of the College of Engineering, the head of the Department of Computer Science, and the head of the Department of Mathematical Sciences. Students in large numbers also participated in the event.

The Conference ended on the 4th day with the Inauguration of the *IORMS LASUSTECH Chapter* with *Dr. Stephen Aderibigbe*, head of the Computer Science Department as Coordinator, who was inducted alongside other 13 Members of staff which included notable deans and heads of departments. Fellowship awards were given to some deserving members of the Institute including *Dr. Marshal Sampson, Dr. (Mrs.) Cynthia Orumie, Prof. Folorunso Ogunwolu, and Prof. Adedeji Badiru (USA)*. An *Honorary Fellowship Award* was given to *Gbenga Francis Ajala*. See: <https://www.youtube.com/live/bSFFU5VS468?si> for a YouTube recording.



▲ *Dr. Olabode* standing with some *LOC* members; a section of participants.

There was also an *Annual General Meeting (AGM)* of the Institute which saw the emergence of New Executives/Governing Council members to pilot the affairs of the institute for another two years. By unanimous decision of members, *Prof. Idorenyin Etukudo*, provost & vice president (academic affairs), Global Institute of Planning and Sustainable Development, who also was *IORMS* South-South coordinator, emerged as the new president and chairman of the Governing Council. 🌍

the Web via R. There was a total of 252 participants - each had the option to choose the module he/she wanted to attend.

The modules aimed to teach the participants how to design and configure ArcGIS Hub to share spatial data and non-spatial content like spreadsheets, tables and summary statistics and enable collaboration with other organizations and the community. They on basic concepts of data analytics and digital transformation were introduced with sample frameworks that can be used to start initiatives in different organizations. They aimed to teach the participants how to differentiate narratives from storytelling, create effective and engaging visualizations that is appropriate to the data and apply storytelling elements in presenting data. >>

>> Furthermore, the participants were introduced to the general procedure of getting data from the web through web scraping or through AP. All the modules discussed led to OR solutions to developing countries' problems.

Conference Keynote Speaker, Mr. Jeffrey Ian C. Dy, Undersecretary, Connectivity, Cybersecurity and Upskilling of the Department of Information and Communications Technology or DICT (<https://dict.gov.ph>) stressed the need for digitalization which is essential for economic growth. He added that data are transformative and that decision-making is always data-driven. What is necessary, according to him, is the ethical use of technology.

The keynote speech was followed by the plenary talk of Ms. Michelle Alarcon, founder of the analytics consulting firm Z-Lift Solutions and co-founder of the Analytics Association of the Philippines (<https://aap.ph>). She discussed that AI and Statistics are closely intertwined and complementary fields that share a deep connection and that AI is a powerful tool that can automate routine tasks, assists in data analysis and provide insights. However, the role of Statistician is to bring domain expertise and critical thinking, ethical considerations and human judgment to the table making them invaluable collaborators in the age of Artificial Intelligence. She further mentioned that data analytics would make OR easier to understand.

Parallel sessions took place in the afternoon where fifteen papers were presented. Papers particularly on OR in the fields of stock markets through different kinds of forecasting techniques; modelling rice pest incidences using binomial logistic regression - binomial logistic regression and

discussed health concerns in the country.



▲ Undersecretary Tan of DICT giving his Keynote Speech.

▲ The author giving the 20 PSAI Annual Conference synthesis during the closing program (left). Participants from the Northern Regions of the Philippines (right).

comparative analysis of global minimum variance and naïve portfolios; performance across stock market indices and selected economic regimes using various risk-return metrics which investigated the impact of short selling on portfolio performance - six time periods are defined for analysis, encompassing events such as global financial crisis and COVID-19 were presented. OR papers on spatial analysis of tuberculosis cases and modelling for calibration of predictions for long time series with applications to dengue cases which

Other sessions consisted of the *Development of Geo-enabled Master Sample Frame Prototype Model from Preliminary 2020 CPH Data Files, using Python QGIS and R; Model-Assisted Approach to Estimate Production and Sales of the Manufacturing Sector in the Philippines; Measuring Advertising Effectiveness through AI; and Reimagining the Philippine Statistical Industry via Blockchain Technology.* All these are solutions to the crises being encountered at present.

Papers on *The Use of AI in Philippines' 2021 Pilot Census on Agriculture and Fisheries; Web Scraping Prices of Commodities Included in the Generation of Consumer Price Index for NCR Region; and Philippines and the Prospects of Data Integration for Philippine Investment Statistics,* discussed OR solutions in the fields of agriculture, fisheries and economics.

The last day of the conference featured two plenary talks: *"Strengthening the Data and Knowledge-base for the Philippine Population and Development Plan of Action for 2023-2028: Call for Collaboration and Partnerships"* delivered by Mr. Lolito Tacardon of the Commission on Population Development. He also presented the Research Agenda of the Commission, gave updates on the trends and challenges of the Philippine Population and explained that demographic transition has taken place. The lecture was reacted upon by known statisticians: Ms. Josephine Almeda of Philippine Statistical Research and Training Institute (<https://psrti.gov.ph>), Mr. Bechayda of the University of San Carlos and Undersecretary Dennis Mapa of PSA. They all gave useful insights on the demographic transition of the Philippine population, demographic dividend and economic growth and also suggested possible operations researches related to the agenda of the commission. The second plenary talk was of Chris Fowler, National Government Business Development Manager, working at the Esri Asia Pacific regional office in Singapore. He stressed the need for PSA to have a Statistical Geospatial Framework that leverages location to ensure the production of high-quality data. In addition, he also discussed that the use of GIS in census operations will show that all data collected will reflect location component.

The two-day annual convention was participated in by more than 500 delegates from different government agencies like Philippine Statistics Authority (www.psa.gov.ph), Local Government Units, academes, and PSAI members.

This Conference was made possible through the combined efforts of the Annual Conference Committee Members and the National Organizing Committee chaired by the former NSO Chairperson Carmelita Ericeta, the PSAI Officers led by Dr. Rosalinda Bautista, the support extended by PSA officers and employees headed by Undersecretary and National Statistician Dennis Mapa and of course the conference sponsors. 🌍

Recent Advances in Multiobjective Optimization, RAMOO 2023, Celebrated at Sapienza

University of Rome

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On September 14th 2023, the *Department of Statistical Sciences of Sapienza, University of Rome* hosted the 10th edition of the annual workshop on “Recent Advances in MultiObjective Optimization”, RAMOO 2023, with the financial support of *Master in “Data Intelligence e Strategie Decisionali”*. The Organising Committee was composed of *Lavinia Amorosi* (Department of Statistical Sciences, Sapienza Università di Roma, Italy) and *Marianna De Santis* (Department of Computer, Control and Management Engineering, Sapienza Università di Roma, Italy).



▲ Group photo of the participants of RAMOO 2023.

RAMOO was held for the first time in Italy and got registrations from nine different countries, including Germany, Portugal, Turkey and Denmark. As for the other editions, RAMOO 2023 was organized as a single-track workshop of one day, highlighting the latest trends in multiobjective optimization, with speakers chosen by invitation. The workshop was divided into three sessions.

The morning session focused on multiobjective continuous optimization, with contributions from *Prof. Ana Luisa Custodio* (Universidade Nova de Lisboa, Portugal), *Pierluigi Mansueto*

(Università di Firenze, Italy) and *Dr. Bennet Gebken* (Universität Paderborn, Germany).

The afternoon session was dedicated to *multiobjective discrete optimization* and we had contributions from *Dr. Michael Stiglmayr* (Bergische Universität Wuppertal, Germany) and *Gökhan Kof* (Koç University İstanbul, Turkey).

The last session was dedicated to a tutorial on *BENSOLVE* and *Dr. Benjamin Weißing* (Libera Università di Bolzano, Italy) gave a talk showing some of the tools of the well-known solver for vector linear programs.



▲ Prof. Matthias Ehrgott giving the second keynote talk entitled: “Walking School Bus Line Routing for Efficiency, Health and Walkability: A Multi-objective Optimisation Approach”.

For this edition, Keynote Talks have been given by *Prof. Gabriele Eichfelder*, from Technische Universität Ilmenau (Germany) and *Prof. Matthias Ehrgott*, from Lancaster University (UK). *Prof. Gabriele Eichfelder* opened the workshop giving a talk related to uncertain multi-objective optimization and optimization with many objectives.

Prof. Matthias Ehrgott talked about a multiobjective model for the walking school bus line routing problem, with a contribution on the stage from *Prof. Judith Wang*.

Further info on the event, including the complete program and the book of abstract can be found at the following link: <https://moo.univie.ac.at/ramoo-2023/program-2023/>. 



▲ Lavinia Amorosi and Marianna De Santis opening the 10th RAMOO workshop.



▲ Prof. Gabriele Eichfelder giving the first keynote talk entitled “Uncertain multi-objective optimization and optimization with many objectives”.



▲ Dr. Benjamin Weißing giving a tutorial on BENSOLVE tools.

6th Annual Meeting of EURO Working Group Retail Operations Successfully held in Stockholm

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In September 2023 the *EURO Working Group Retail Operations* convened for their 6th annual meeting, this time at *Stockholm Business School, Stockholm University* in Stockholm, Sweden. 70 people from North America, Asia and Europe participated in the two-day event. This year the annual meeting was preceded by the *Summer School on Retail Operations*, creating a full cohesive week of lectures, workshops and discussions focusing on Retail Operations.



▲ Meeting EWG Retail Operations: Walk through the historical part of Stockholm.

The purpose of the *EURO Working Group on Retail Operations* is to advance the development and application of quantitative methods in the field of Retail Operations. Over the last decades the retail industry has gone through a complete transformation. Just twenty years ago the retail industry was completely dominated by brick-and-mortar stores. Now retailers in developed and developing countries alike are becoming increasingly sophisticated, with advanced operating concepts combining online and offline operations. Traditional retailers have been forced to rethink their operations, and new retailers have emerged. This has created a large need for, and interest in, research to better understand how different operating models and concepts can be implemented to increase efficiency and minimize environmental and social impact of the operations. The large interest was reflected in the summer school and the annual meeting, which saw a large number of high quality applications and contributions.

students were exposed to theory and worked with solving several examples using Python. On the second day *Fredrik Eng-Larsson* and *Olov Isaksson* from Stockholm Business School lead a full day on causal inference. Students were introduced to important ideas, concepts and tools when analyzing causal mechanisms in operations settings where there might be endogeneity issues, which is often the case in the retail industry. The third and final day was led by *Victor Martínéz-de-Albéniz* from IESE Business School. Together with the students he went through a last-mile delivery case. After the case discussion, the students were introduced to two large data sets and were tasked to form groups and write a “mini research paper” using the data and the tools they had learned over the week.



▲ Meeting EWG Retail Operations: Opening of meeting by Pedro Amorim.

The week started with the summer school. 25 students from Europe and North America participated (and more were on the waiting list). The idea of the summer school was two-fold. First, to provide Ph.D. students with state-of-the-art tools to analyze and solve operations problems in the retail industry using data; there are many recent developments in both computer science and econometrics that are relevant for operations researchers. Second, to help students build their professional network and learn from each other.

The first day of the summer school focused on machine learning applied to operations management problems in the retail industry. *Ali Aouad* from London Business School and *Antoine Desir* from INSEAD lead a full-day workshop where

While the days were filled with academically intense workshops, evenings focused on equally intense, albeit not academically so, pétanque tournaments at Boulebar, and karaoke and Eurovision-flavored entertainment at the ABBA museum.

The annual meeting kicked off on the Thursday, right after the summer school, with presentations ranging from add bidding in online retail (*Naren Agrawal*, “*Dynamic two-part pricing and bidding for display ad campaigns*”) to the impact of digital tools in nanostores (*Simone Balvers*, “*Understanding the impact of the adoption of digital ordering solutions on the ordering behavior of nanostores*”) to estimators for food waste in grocery retail (*Karel van Donselaar*, “*A simple estimator for food waste in retail*”). This shows not just the breadth of current retail operations problems but also the applicability of operations tools to analyze and improve retail operations. Since several practitioners attended the meeting (e.g., H&M, Migros, and Kaufland), the first day ended with a panel discussion about the future of retail operations, and how academy and industry can best collaborate to solve pressing problems and move retail operations forward.

The second day saw a key note presentation by *Antonio Moreno* from Harvard Business School on “*Assortment Curation in Online Marketplaces*”, drawing attention to the importance of understanding the online market places that are controlling an ever larger share of online retail. >>

Other presentations focused on e.g. sustainability in apparel retail (Jean-Sebastien Matte, "Lowering the environmental impacts of fashion retail assortments: Balancing profit maximization and impact minimization") and labor costs of online grocery retail (Santiago Gallino, "Navigating the Future of Online Grocery: Labor, Pricing, and the E-commerce Paradox"). The second day also saw the prize for the best poster go to Moritz Hundhammer et al. for their poster on "Store delivery planning for peak seasons in grocery retailing". The full program can be found here: <http://www.ewg-retail-ops.eu/pastevents/>.



▲ Meeting EWG Retail Operations: during an exciting session.

Apart from presentations and poster discussions, the conference included a walking tour of Stockholm's historic Gamla Stan quarters and group dinners in historic restaurant Pelikan as well as in the City Hall, home to the Nobel banquet. 🌍

The Subject to (s.t.) Podcast Inspiring interviews with dozens of OR personalities across the globe and more than 60,000 views on YouTube

Anand Subramanian <anand@ci.ufpb.br>

The "Subject to" (s.t.) podcast offers a series of informal conversations with relevant figures in the fields of Operational Research, Combinatorial Optimization and Logistics, and they are hosted by Anand Subramanian, an Associate Professor at Universidade Federal da Paraíba (UFPB), Brazil. The episodes can be accessed on YouTube (https://www.youtube.com/@Subjectto_), as well as various podcast platforms (<https://podcasters.spotify.com/pod/show/subject-to>) such as Spotify, Google, Apple, etc.

The goal of the s.t. podcast is to inspire the next generation of operation researchers by means of informal yet in-depth conversations with great names in the field of OR in the form of oral history. Moreover, in addition to providing technical insights, the podcast attempts to portray the human side of the guests, otherwise generally known only for their work, by walking through their professional and personal life stories.

The episodes often touch on societal elements such as gender and diversity issues, and other pertinent non-technical topics like the best strategies to better promote the field.



▲ Podcast Logo

So far, there have been 77 episodes with many important names from 26 different nationalities (Italy, Brazil, Chile, Canada, Belgium, Portugal, Spain, Greece, Russia, Norway, Austria, Denmark, India, United States, Germany, Iran, China, England, Turkey, Romania, Czech Republic, Philippines, Australia, Colombia, Netherlands, New Zealand) spread across 22 countries all over the world. Most of his 48 male and 29 female guests are from academia, but some of them are in the industry.



▲ The first 75 guests of the s.t. podcast. Guests displayed in chronological order of appearance.

Here is the list of guests divided by seasons, which includes several IFORS presidents (marked with *).

- Season 1 (2021): *Maria Battarra, Rafael Martinelli, Claudio Contardo, Manuel Iori, Luciana Buriol, Jean-François Côté, Dorien Herremans, Helena Ramalhinho Lourenço, Leandro Coelho, Roberto Roberti, Mauricio Resende, Juan-José Salazar-González, Panos Pardalos, Fabio Furini, Anna Nagurney, Alysson Costa, Ruslan Sadykov, Maria Grazia Speranza*, Sin Ho, Sophie Parragh, David Pisinger, Eduardo Uchoa, and Natarajan Subramanian* (father's day special).

- Season 2 (2021): *Claudia Archetti, Michel Gendreau, Laura Albert, Nelson Maculan*, Dolores Romero-Morales, Marco Lübbecke, Soroush Saghaifan, Thibaut Vidal, Margaret Brandeau, Janny Leung*, Dimitris Bertsimas, José Fernando Gonçalves, Graham Rand, Sibel Alumur Alev, Teodor Gabriel Crainic, Radhika Kulkarni, and Warren Powell.*

- Season 3 (2022): *Vašek Chvátal, Andrés Weintraub*, Andrea Lodi, Martine Labbé, Adam Letchford, Elise del Rosario*, Shylaja Subramanian* (mother's day special), *Mario Pereira, Luce Brotcorne, Martin Schmidt, Tom Van Woensel, Claudia D'Ambrosio, Kate Smith-Miles, Andrés Medaglia, Phebe Vayanos, Jeff Linderoth, Ramyya Krishnan, and Pooja Dewan.*

- Season 4 (2023): *Martin Savelsbergh, Ricardo Fukasawa, Greet Vanden Berghe, Francisco Saldanha da Gama, Maryam Darvish, Rubén Ruiz, Frédéric Semet, Andy Philpott, Karen Smilowitz, Gilbert Laporte, Haroldo G. Santos, Francesca Maggioni, Tobias Achterberg, Bruce Golden, Margarida Carvalho, Jayme Swarcfiter, Paolo Toth*, and Karla Hoffman* (so far).

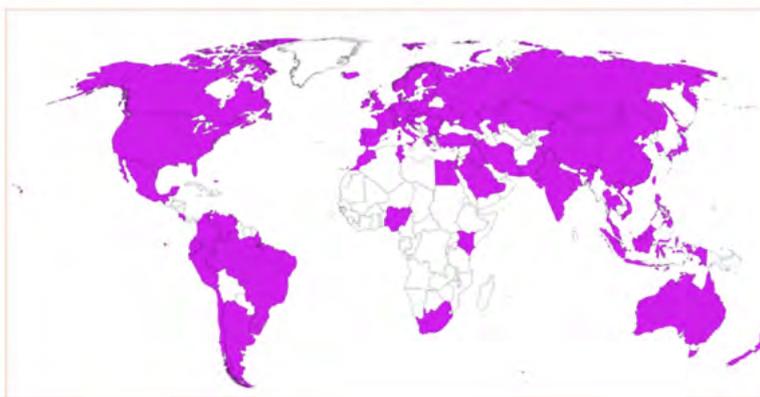
The YouTube channel has around 2,200 subscribers and more than 61,700 views. Viewers/listeners from about 75 countries across the globe have accessed the podcast.



▲ Anand Subramanian, organizer and host of the s.t. Podcast.

The podcast has been critically acclaimed by the OR community worldwide. According to Prof. Narayan Rangaraj (Professor at IIT Bombay and a fellow of the Indian OR society), "This series has archival value in the field, documenting the personal evolution and experiences of so many. Anand's homework and diligence is inspirational, and shows genuine interest in the human behind the science." Furthermore, Prof. Dimitris Bertsimas (Professor at MIT) believes that the s.t. project "will become the definitive oral history of Operations Research".

Recently, Anand met many of his guests in person at the 23rd Triennial Conference on Operational Research of the IFORS (IFORS 2023; <https://ifors2023.com/>), held in Santiago, Chile. In addition, he organized a session on "combinatorial optimization



▲ Countries that have accessed the s.t. podcast across the globe.

problems under uncertainty", alongside his fellow colleague Teobaldo Bulhões, and presented a work titled "A matheuristic approach for a class of vehicle routing problems under time and demand uncertainty", co-authored with Carlos Neves (UFPB) and Pedro Munari (Universidade Federal de São Carlos, UFSCar).

Also at the conference, Anand and his team from UFPB, namely, Bruno Bruck (Adjunct Professor at UFPB), Teobaldo Bulhões (Adjunct Professor at UFPB) and Renata Mendes (undergraduate student) contributed with the work titled "An optimization model for a real-life single-track train timetabling problem", which was presented by Renata in the cluster in OR for Developing Countries. 🌍



▲ Meeting the s.t. guests at the 23rd Triennial Conference on Operational Research, IFORS 2023 in Santiago: Claudio Contardo, Laura Albert, Dolores Romero-Morales, Maria Grazia Speranza, Andrés Weintraub, Helena Ramalhinho Lourenço, Janny Leung, Margaret Brandeau, Claudia Archetti, Elise del Rosario, Juan-José Salazar-González, Andrea Lodi, Kate Smith-Miles, Andrés Medaglia, Mauricio Resende, Anna Nagurney.



▲ Delegation of the Logistics and Optimization Group at UFPB (LOG-UFPB) at the 23rd Triennial Conference on Operational Research of the IFORS (left to right): Teobaldo Bulhões, Bruno Bruck, Renata Mendes, Anand Subramanian, and Pedro Munari.

Latest advances in research, practice, and developments of OR: SEMIT 2023 Ankara, Turkey, online

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The *International Conference on Science, Engineering Management and Information Technology 2023 (SEMIT 2023;* cf. <https://semit2023.refconf.com/>) was held virtually on September 14-15, 2023 to provide a great opportunity for the exchange of knowledge, expertise and experience in the field of *Operational Research (OR)*.

The *Conference Chairs* were Prof. A. Mirzazadeh (Kharazmi University, Tehran, Iran, <https://eng.khu.ac.ir/cv/326/english>), and Prof. Mete Gundogan (Ankara Yildirim Bayezit University, Turkey). The *Coordinators* of the conference were Ms. Leyla Chehrghani (Kharazmi University, Tehran, Iran, <https://khu.ac.ir/en>), Dr. Zohreh Molamohamadi (Kharazmi University, Tehran, Iran), and Dr. Roya Soltani (Khatam University). SEMIT 2023 was supported by Ankara Yildirim Bayezit University (<https://aybu.edu.tr/aybu/en>), Prof. Dr. Ali Cengiz Köseoğlu (Rector), Prof. Hasan Okuyucu (Dean of Faculty of Engineering and Natural Sciences), and Dr. Babek Erdebilli (IE Department Board Member). Moreover, various universities from Czech Republic, USA, UK, Malaysia, Algeria, Morocco, Tunisia, and Turkey provided scientific support of SEMIT 2023.

SEMIT 2023 conference included several scientific programs, such as keynote speeches, workshops, and papers presentations panels, which covered a variety of subjects in OR, data science, decision making and support systems, Internet of Things, etc.

The *Opening Ceremony* was inaugurated with the welcome speech of Prof. Hasan Okuyucu (AYBU Dean of Faculty of Engineering and Natural Sciences) and followed by AYBU introduction clip. Then Prof. A. Mirzazadeh presented the SEMIT 2023 conference report (https://semit2023.refconf.com/page_150.html) and the achievements clip of SEMIT



▲ SEMIT 2023: Chairs (from left to right): Prof. A. Mirzazadeh and Prof. Mete Gundogan.



▲ SEMIT 2023: AYBU Colleagues (from left to right): Prof. Ali Cengiz Köseoğlu, Prof. Hasan Okuyucu, and Dr. Babek Erdebilli.



▲ SEMIT 2023: Coordinators (from left to right): Ms. L. Chehrghani, Dr. Zohreh Molamohamadi, and Dr. Roya Soltani.

2023 was shown to the participants. After that, Prof. Dolgui (IMT Atlantique, campus in Nantes, France: Editor-in-Chief, International Journal of Production Research), presented a valuable keynote speech and the opening ceremony ended with the IJSOM clip.

The Invited Talks of the conference

•Prof. Alexandre Dolgui (Fellow of IISE, Distinguished Professor) AI in Manufacturing: Example of a Large European Project ASSISTANT
•Prof. Gerhard Wilhelm Weber (Poznan University of Technology, Poland) Optimal Management of Defined Contribution Pension Funds under the Effect of Inflation, Mortality and Uncertainty
•Prof. Sima Zeynep Alparslan Gök (Süleyman Demirel University, Turkey) Cooperative Game Theory under Interval Uncertainty and its Applications on Economics and Operations Research Situations (in memory of Prof. Dr. Stel Tjjs)
•Dr. Mostafa Hajiaghaei-Keshteli (Tecnologico de Monterrey, Mexico) Recent Advances in Agriculture Supply Chain Network Design
•Prof. Anand Nayyar (Duy Tan University, Da Nang, Vietnam) Internet of Medical Things and Artificial Internet of Medical Things: Revolutionizing Healthcare

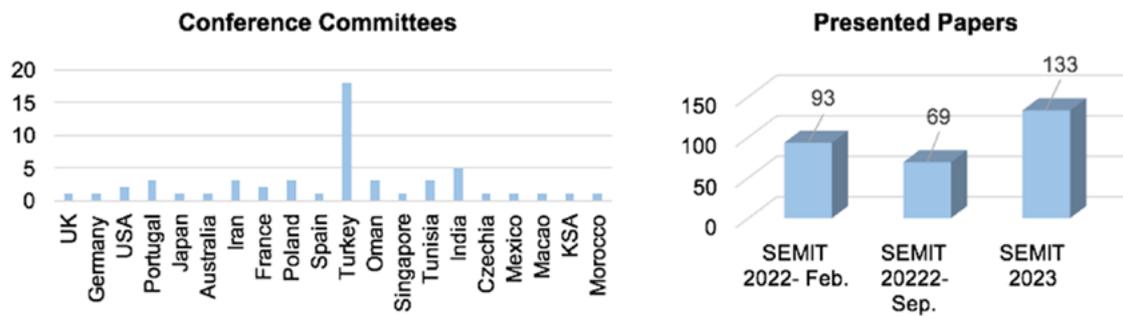
The four Workshops

Product as a Service (PaaS) with Value Retention Processes; Research Implications for Engineering Management from Introducing Circular Business Models	•Prof. Paulina Golinska-Dawsons (Poznan University of Technology, Poznan, Poland)
Latest Digital Transformation & Digital Technology Trends in the global business world	•Prof. Meenakshi Kaushik (Guru Gobind Singh Indraprastha University, Delhi, NCR, India)
Supervised machine learning using the Scikit-learn Library	•Prof. Safa Bhar Layeb and Marwa Hasni (University of Tunis El Manar, Tunisia)
Dissemination of Digital Youth Life Health Platform (DYL-HP) - Project Supported by the European Union	•Prof. Servet Soygüder (Ankara Yildirim Bayezit University, Turkey)

SEMIT 2023 gathered 900 participants from 54 countries, with 409 paper submissions, from which 133 were selected for presentation and incorporated into 24 panel sessions (https://semit2023.refconf.com/page_124.html).

Some of the selected papers will be published in Springer's CCIS book series, which will be indexed in Scopus, SCImago, EI-Compendex, etc., and some others will be considered for possible publication in peer-reviewed Journals, e.g., Central European Journal of Operations Research (CEJOR), Operations Research Perspectives (ORP), International Journal of Supply and Operations Management (IJSOM), Journal of Turkish Operations Management (JTOM), Iranian Journal of management Studies (IJMS), Researcher Journal and Journal of Optimization and Decision Making (JODM).

The conference committees were from 20 countries and there was considerable increase in the number of presented papers, compared to SEMIT 2022-Feb. and SEMIT 2022-Sep.



▲ SEMIT 2023: Geographical Diversity of Conference Committees Members (left) and Comparison of the Presented Papers to the Last Year's Events (right).



▲ SEMIT 2023: Keynote speakers (from left to right): Prof. Alexandre Dolgui, Prof. Gerhard Wilhelm Weber, Prof. Sirma Zeynep Alparslan Gök, Dr. Mostafa Hajiaghaei-Keshteli, Prof. Anand Nayyar



▲ SEMIT 2023: A Snapshot from the Closing Ceremony.

The SEMIT 2023 highlights was shared with participants during the Closing Ceremony and the closing remarks were given by Prof. Mete Gundogan (Yildirim Beyazit University, Turkey) and Prof. Gerhard Wilhelm Weber (Poznan University of Technology, Poznan, Poland; IAM, METU, Ankara, Turkey).

The OC of SEMIT 2023 is grateful to the authors and researchers for providing valuable scientific discussions that has greatly contributed to the richness of the conference by thinking of new solutions for emerging problems. 🌍

The Argentine Symposium on Industrial Informatics and OR returned to the in-person format in 2023

Mariana E. Cóccola <marcoccola@santafe-conicet.gov.ar>, **Javier Marengo** <javier.marengo@utdt.edu>, **Analia Rodríguez** <r_analia@santafe-conicet.gov.ar>

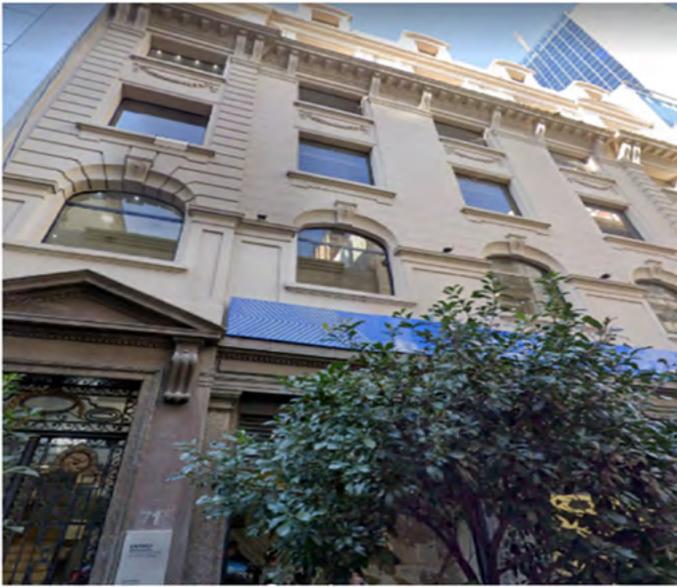
The Argentine Symposium on Industrial Informatics and Operations Research (SIIO) is the main gathering point for the OR community in Argentina. This symposium is held annually and provides a forum to discuss and exchange ideas, knowledge, and experiences. It is one of the symposia regularly included in the Argentine Conference on Informatics (JAIIO), organized by the Argentine Society of Informatics (SADIO) since 1961.



▲ Downtown Buenos Aires (credit to <https://turismo.buenosaires.gob.ar>).

The 2023 edition of SIIO was held in Buenos Aires, Argentina,

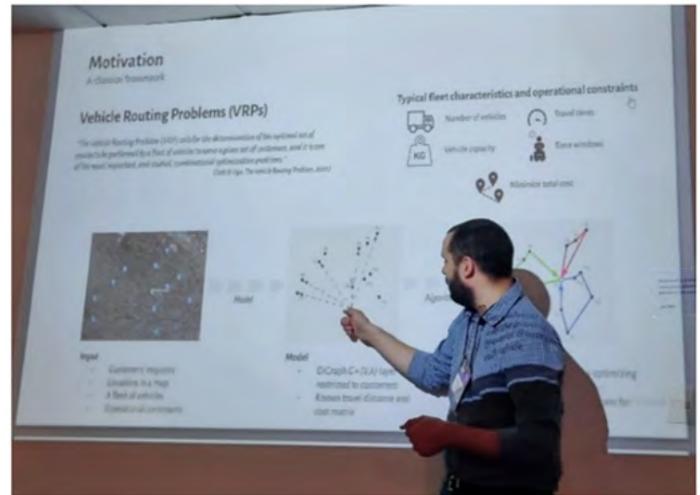
as part of the 52nd edition of JAIIO, and marked the return to the in-person format for this symposium. After a rigorous selection procedure, 23 contributed presentations were accepted for presentation at the two-day symposium. >>



▲ Venue of SIIIO 2023 (credit to Google StreetView).



▲ SIIIO 2023: Invited Speaker Prof. Joaquín del Priore.



▲ SIIIO 2023: Invited Speaker Prof. Juan José Miranda Bront.

>> Also, SIIIO 2023 featured invited presentations by Juan José Miranda Bront (Universidad Torcuato Di Tella, Argentina) and Joaquín del Priore (Mercado Libre, Argentina). Prof. Miranda Bront gave a survey on vehicle routing problems with congestion effects, whereas Joaquín del Priore presented some of the outstanding work on OR that Mercado Libre, the main e-commerce company in Latin America, is performing.

The detailed program and further conference information can be found at the JAIIO website: <https://52jaiio.sadio.org.ar>. The next edition of SIIIO will be held in 2024 in Bahia Blanca City, we hope to meet many colleagues from the OR community there! 🌍

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“Fundamentals of Convex Analysis and Optimization – A Supremum Function Approach”

By **Rafael Correa, Abderrahim Hantoute and Marco A. López**

Springer Series in Operations Research and Financial Engineering

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<https://doi.org/10.1007/978-3-031-29551-5>

OR-Analytics – Convex Optimization through a supremum function approach

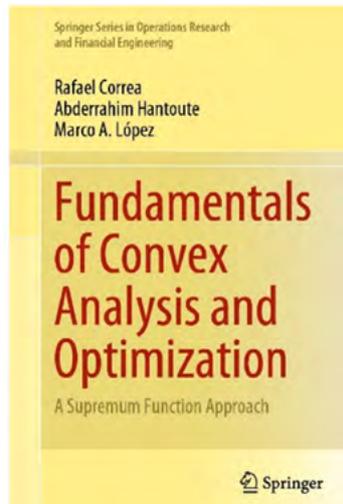
Jinal Parikh <jinal.parikh@ahduni.edu.in>,

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This book by *Rafael Correa, Abderrahim Hantoute and Marco A. López* which provides a novel approach to convex analysis and convex optimization, based on subdifferential calculus of pointwise suprema of convex functions, is an enriching addition to the series of scholarly contributions in Operational Research and Financial Engineering published by Springer. The main goal of this book consists of analyzing the subdifferential of the supremum of an arbitrary collection of convex functions, defined on a separated locally convex space, in terms of the subdifferentials of the data functions. The authors provide a series of results aligned with this goal, but in different settings and under different assumptions. Since many convex functions such as the Fenchel conjugate, the sum, the composition with affine applications, etc.

can be written as a supremum, the formulas provided in the book lead to calculus rules unifying many results in the extant literature. The mathematical interest in the main subject of the book has been widely recognized by erudite mathematicians reminded by the authors, like *B.N. Pshenichnyi, A.D. Ioffe, V.L. Levin, R.T. Rockafellar, A. Sotskov, A. Brøndsted, F.H. Clarke, J.M. Danskin, J.-B. Hiriart-Urruty, R.R. Phelps, V.H. Tikhomirov, V.L. Levin, O. Lopez, L. Thibault, B.S. Mordukhovich, T. Nghia, M. Valadier, M. Volle*, and many more, since the very beginning of convex analysis history.

The book presents explicit characterizations for the subdifferential mapping of the supremum function of an arbitrarily indexed family of convex functions defined on a separated locally convex space, exclusively in terms of data functions. In the most general context, the index set over which the supremum is taken is arbitrary, without any algebraic or topological structure. Furthermore, the authors have not assumed regularity conditions such as continuity of the supremum function, continuity of the data functions, conditions on their domains, and the like. Since many convex functions can be written as the supremum of families of convex functions, a unified approach for the framework of calculus rules in convex analysis has been considered. The authors’ characterizations of the subdifferential of the supremum function, enable them to obtain formulas for the subdifferential of the resulting function in many operations



▲ *OR-Analytics – Convex Optimization through a supremum function approach.*

such as the sum of convex functions, the composition of an affine continuous mapping with a convex function, and conjugation. This approach by the authors provides more direct and easier proofs for the basic chain rules assuming supplementary qualification conditions, and gives rise to a unifying view of many well-known calculus rules in convex analysis.

Any formula for the subdifferential of the supremum function can be seen as a useful tool in deriving Karush-Kuhn-Tucker optimality conditions for a convex optimization problem. This is because any family of convex constraints, can be replaced with a unique convex constraint via the supremum function. An alternative approach consists of replacing the constraints with the

indicator function of the feasible set. It turns out that, under certain constraint qualifications, its subdifferential (i.e., the normal cone to the feasible set) appears in the so-called Fermat optimality principle, and its relation to the subdifferential of the supremum function can then be exploited. The authors have meticulously chosen the context of locally convex spaces to propose the formulations of their results so that they represent maximum generality with the pre-existing results in the literature. The authors have pertinently supplemented the book with around 40 examples to clarify the meaning of concepts and results. Each chapter concludes with a list of exercises which are strongly related to its contents. Some of them are used inside the proofs of some results to shorten them by keeping exclusively the core part of the arguments. The last section of each chapter, entitled “Bibliographical notes”, is devoted to supplying historical notes, comments on related results, etc.

The book is well-organized, well-structured, mathematically sound, timely, and easy to understand. It provides a novel approach to convex analysis and convex optimization, based on subdifferential calculus of pointwise suprema of convex functions. It is intended to cater to a wide range of readers including optimizers, mathematical analysts, operational researchers, graduate and doctoral students in mathematics, economics, physics, engineering, etc., and to specialists and practitioners in convex analysis and optimization.

A brief summary of the contents of this book follows:

Chapter 1 - Introduction intends to motivate the reader and provide a detailed account of the objectives and contents of the book, and their relation to antecedents in the literature.

Chapter 2 - Preliminaries describes the background material, including a brief introduction to locally convex spaces, duality pairs, weak topologies, separation theorems, and the Banach-Alaoglu-Bourbaki theorem, among other basic results. Next, it reviews the relation between convexity and continuity followed by presenting typical examples of convex functions.

Chapter 3 - Fenchel-Moreau-Rockafellar theory provides an extensive background on convex analysis, including preliminary results and the notation used in the book. Special emphasis is put on the Fenchel-Moreau-Rockafellar theorem and its consequences, including dual representations of the support function of sublevel sets and extensions of the minimax theorem.

Chapter 4 - Fundamental topics in convex analysis presents an in-depth study of key concepts and results involving the subdifferential and the Fenchel conjugate, such as the duality theory, integration of the subdifferential, convexity in Banach spaces, subdifferential calculus rules, etc.

Chapter 5 - Supremum of convex functions describes the characterizations and presents the proofs and derivations of the various formulas of the subdifferential of the supremum function.

Chapter 6 - The supremum in specific contexts provides formulas for the subdifferential of supremum functions in specific contexts.

Chapter 7 - Other subdifferential calculus rules emphasizes the



▲ Book authors: *Rafael Correa* (https://www.cmm.uchile.cl/?cmm_people=rafael-correa), *Abderrahim Hantoute* (https://www.cmm.uchile.cl/?cmm_people=abderrahim-hantoute), *Marco A. López* (<https://rac.es/sobre-nosotros/miembros/academicos/correspondiente-nacional/960/>).

unifying character of the supremum function in modeling most operations in convex analysis. It characterizes the subdifferential of the sum and the composition with linear mappings by establishing general formulas for convex functions under different settings.

Chapter 8 - Miscellaneous presents the results of some selected topics related to the material in the previous chapters. The first part provides constraint qualifications, such as the Farkas-Minkowski property in infinite convex optimization. The next part establishes different Karush-Kuhn-Tucker and Fritz-John optimality conditions for infinite convex optimization. This chapter also gives an account of other applications devoted to convexification processes in optimization, integration in locally convex spaces, variational characterizations of convexity, and the theory of Chebyshev sets.

Chapter 9 - Exercises - Solutions covers a total of 131 exercises from all the previous chapters and their solutions.

While this book looks at *OR-Analytics* and describes convex optimization based on the supremum function approach through a powerful mathematical and especially theoretical lens, many more scientific, practical and real-world applications - from quantum computing to logistics in space - can be explored by it in various areas across our wide scope and rapidly growing universe of contemporary research. 🌍

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