

# IFORS

International Federation of Operational Research Societies

NEWS

## From the President

### The IFORS 2021 Conference

Grazia Speranza <grazia.speranza@unibs.it>



I am writing this editorial a couple of weeks before the IFORS2021 conference, even though, when the issue of the newsletter will be ready and this editorial will be read, the conference will have taken place already.

With its 54 member societies, organized in 4 regional groupings - ALIO, APORS, EURO and NORAM - IFORS is the mother of all operational research societies on the planet. The IFORS Statutes, approved in 1959, stated the purpose of the Federation as "the development of operational research as a unified science and its advancement in all nations of the world." The first conference, in fact, took place in 1957, and was one of the defining moments of IFORS. Since then, we have had 21 IFORS conferences, one every 3 years. The 22nd IFORS conference was scheduled to take place in Seoul in 2020, after the previous one which was successfully held in Quebec City in 2017. Only a pandemic could interrupt the regularity of our conferences. During the first months of the pandemic we hoped to just postpone the conference from June 2020 to the end of 2020, but later in the year we had to accept that it was impossible to have the conference in 2020. We then hoped to have an in-person conference in August 2021 but unfortunately also this turned out to be impossible. The IFORS2020 conference was renamed IFORS2021.

About 800 people are registered to the conference. I am impressed that so many academics and practitioners have chosen to participate, despite the fact that the conference is held in virtual format and that many conferences take place this year because almost all those scheduled in 2020 have been postponed to 2021.

I am extremely grateful to the Local Organizing Committee, chaired by Professor Suk-Gwon Chang, and to the Program Committee, co-chaired by Professors Natasha Boland and Bernard Fortz. Due to the pandemic, their work has been even more difficult and stressful than it would have been in a normal situation. I am also grateful to all the colleagues who have worked hard to make this conference possible.

With 3 plenary and 10 keynote presentations of leading international scientists, more than 700 invited and contributed presentations, and a number of other scientific and social events, I am sure the 22nd IFORS conference has offered a fruitful and unforgettable experience to our international community.

The next IFORS conference will take place in Chile in 2023, as planned before the pandemic. I already now invite you to consider this exciting new IFORS conference in your future plans. 🌐

## What's Inside

#### 1. From the President

Grazia Speranza

#### 2. From the Editor-in-Chief

Sunity Shrestha Hada

#### 3. OR and Development

OR/AI techniques with HR remote sensing and large scale mapping to estimate the Amazon rainforest carbon sequestration

#### 4. Tutorial

Challenges in Solving Multiobjective Mixed Integer Nonlinear Problems

#### 5. OR Impact

Optimizing National Grid UK Electricity Transmission Assets with the Copperleaf Decision Analytics Solution

#### 6. IFORS Global Webinar

Gender Diversity in the World

#### 7. Conferences

From Genome Mining, Wildfire Detection, to Digital Marbling Art

EUROPT Workshop 2021

EURO 2021

3rd IMA and OR Society Conference on Mathematics of OR

ASIP 2021: A pioneering event.

ECCO XXXIV

SIAM in Philadelphia, USA

OR Road-to-Future Forum in 2021

MCDA-MSS 2021)

Production and Operations Management Society's 31st Annual Conference

ICVNS 2021

News from the EURO WISDOM Forum:

#### 8. Book Review

Optimal Control Problems Arising in Forest Management

#### 9. Call for Papers

#### 10. Editorial Box

**Sunity Shrestha Hada** <sunity.shresthahada7@gmail.com>

The 22nd IFORS triennial conference 2021 at Korea in virtual format is the mega event of IFORS and all OR academicians, practitioners and OR scientists are looking forward to the grand success of this event. The September issue is getting ready when we are involved in the conference activities, and the next issue of the newsletter in December 2021 will cover the reports on successful completion of this conference.

The September issue includes research articles in the permanent sections of the newsletter. OR for Development section presents the article on "OR/AI techniques with HR remote sensing and large scale mapping to estimate the Amazon rainforest carbon sequestration" written by Rosiane de Freitas, João Marcos Cavalcanti and Niro Higuchib. The OR Impact section presents the article on "Optimizing National Grid UK Electricity Transmission Assets with the Copperleaf Decision Analytics Solution" written by Stefan Sadnicki. And the article on Tutorial presents "Challenges in Solving Multiobjective Mixed Integer Nonlinear Problems" written by Marianna De Santis. The team of section editors, Rosiane de Freitas, John Ranyard, Sue Merchant and Javier Marenco are highly appreciated for their continuous support. Gerhard Willi Weber has presented 12 conference reports in this issue. The reports are from different parts of the world and almost all conferences held online and few in hybrids format. The book "Optimal Control Problems Arising in Forest Management" written by Alexander J. Zaslavski is reviewed by Gerhard-Wilhelm Weber and Joanna Majchrzak.

The call for papers for two special issues of Sustainability Analytics and Modeling (SAM), Sustainability in Retail Supply Chains and Frontier Methods for Sustainability Challenges in the new journal of IFORS are an addition to this issue.

We still need to take care of the health as the COVID is not yet eradicated. Take care and be safe. 🌍



## OR and Development

# OR/AI Techniques With HR Remote Sensing And Large Scale Mapping To Estimate The Amazon Rainforest Carbon Sequestration

**Rosiane de Freitas** <sup>(a,b)</sup>, **João Marcos Cavalcanti** <sup>(b)</sup>, **Sergio Cleger** <sup>(a)</sup>, **Niro Higuchi** <sup>(c)</sup>, **Adriano Lima** <sup>(c)</sup>, **Carlos Henrique Celes** <sup>(c)</sup>

<sup>(a)</sup> Optimization, Algorithms, and Computational Complexity CNPqResearch group, <sup>(b)</sup> Institute of Computing, Federal University of Amazonas – IComp/UFAM, Manaus-AM, Brazil

<sup>(c)</sup> Forest Dynamics and Management Laboratory, The National Institute for Amazonian Research - LMF/INPA, Manaus-AM, Brazil.



Based on the directives given by the IPCC (The Intergovernmental Panel on Climate Change), where there is an urgent need to provide additional guidance on the design of forest monitoring systems including issues such as forest inventory design, stratification, sampling, pools, accuracy/uncertainty assessment and the combination of ground-based inventories with remote sensing and modelling approaches [Gauí (2019)]. We are interested in estimating carbon stocks by means of extrapolation and spatialization based on ground-based forest inventory combined with heterogeneous sources of remote sensing images through high-resolution satellite, radar and LiDAR ((Light Detecting And Ranging) 3D technology. One of our objectives consists to determine a set of representative trees - the widest (dominant) and the highest (emerging) - through the application of operational research

with computational intelligence strategies involving pattern recognition, graph theory, image retrieval, machine learning and combinatorial optimization techniques.

The Amazon rainforest, with its dense tangle of trees, is responsible for the sequestration and storage of about 20% of the total carbon contained in the world's terrestrial vegetation. It is the world's largest tropical rainforest encompassing up to 2,124,000 sq mi, covering a large area in South America including nine countries, where 69% of that area is in Brazil (Figure 01). But, the rampant deforestation to illegal logging, mining, cattle ranching, and soy plantation, are examples of threats. Biodiversity loss, ecosystem imbalance, and higher concentration of carbon dioxide in the atmosphere is related consequences.





▲ Figure 01 – Amazon rainforest - a twisted entanglement of tree branches.

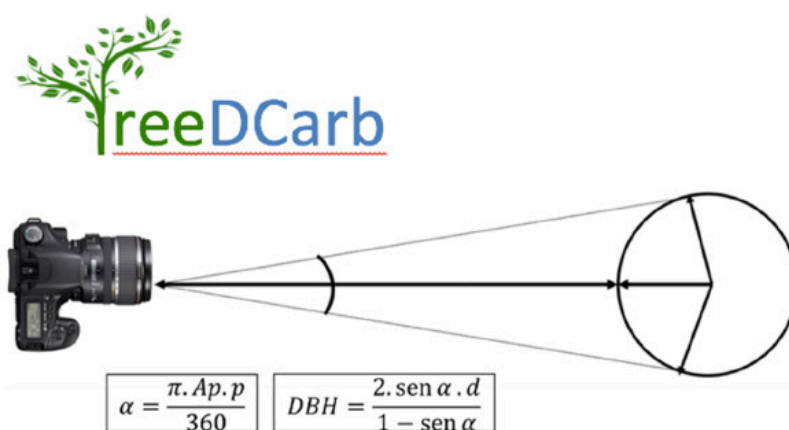
To refine the carbon stock estimate, complementary related research consists of the detection of clearings in the Amazon forest based on satellite and radar images using machine learning techniques is a valuable tool in the effort to the environment conservation. However, small-scale clearing is a challenge. This is a trend hindering detection from satellite monitoring.

### Identification of Representative Plots for the Optimization of the Carbon Capture Estimation Process

The forest inventory is the collection of attributes about the quantitative and qualitative characteristics of the forest, providing information on forest resources that are applied to monitoring, forest management policies, as well as strategic actions to exploit resources in a sustainable way. Among this information, we highlight the measures of biodiversity, social aspects of the forest and biomass and carbon stocks. On the other hand, the biomass of a forest is the quantity, by mass, of living or dead matter, present in the vegetation or only in its arboreal fraction. In general, it is measured by allometric equations developed by forest engineers. These equations make use of forest attributes given as inputs for their calculation, such as tree height, vegetation index, diameter at breast height (DBH), tree crown diameter, among others. Its estimation is useful and stands out as an ecosystem assessment tool. Figure 02 shows the Tree-DCarb app to determine the DBH of a tree. Through it is possible to carry out analyzes of productivity, energy conversion, nutrient cycling, absorption and storage of solar energy, as well as estimating the carbon storage. The latter can be estimated from forest

biomass because the forest absorbs and stores carbon in its mass when it is in its development and growth phase. Therefore, forests act as sinks of carbon when they are in their phase of expansion and development. We developed a mobile application for the automatic determination of DBH (three-dimensional structure), through the analysis of the photo from the camera of a rugged smartphone applying image processing and computational geometry techniques (Figure 02). Thus, given a forest region to be inventoried to estimate the carbon stock, it is important that the samples, or plots, be installed in places where there are more representative trees: the dominant (e.g., the largest) and the emerging (tallest) trees. In the field survey, only the dominant trees are identified. On the other hand, from data by LiDAR (Light Detection And Ranging) it is possible to identify emerging ones [Freitas (2016), Junttila (2013)] (Figures 03-04).

In this work, the problem of determining the most representative parts of the forest was modeled as a Maximal Covering Location Problem (MCLP), which is NP-hard [Church, R. & ReVelle C. (1974), Farahani (2012)]. In this problem we have a set of plots from which the most representative ones will be extracted. In the MCLP model, therefore, the facilities will be the most representative plots and the demand will be each of the candidate plots. The representativeness index of the plots was calculated based on the sum of the average height of the trees of its  $n$  adjacent plots (Figures 10-11). Based on the proposal by Resende (1998), the Greedy Randomized Adaptive Search Procedure (GRASP) meta-heuristic was adapted for the MCLP, indicating the potential for using the strategy on a large scale.



▲ Figure 02 – Tree-d Carb app - automatic determination of the DBH measure of a tree (Diameter at breast height) through the analysis of the photo from the camera of a rugged smartphone applying image processing and computational geometry techniques.

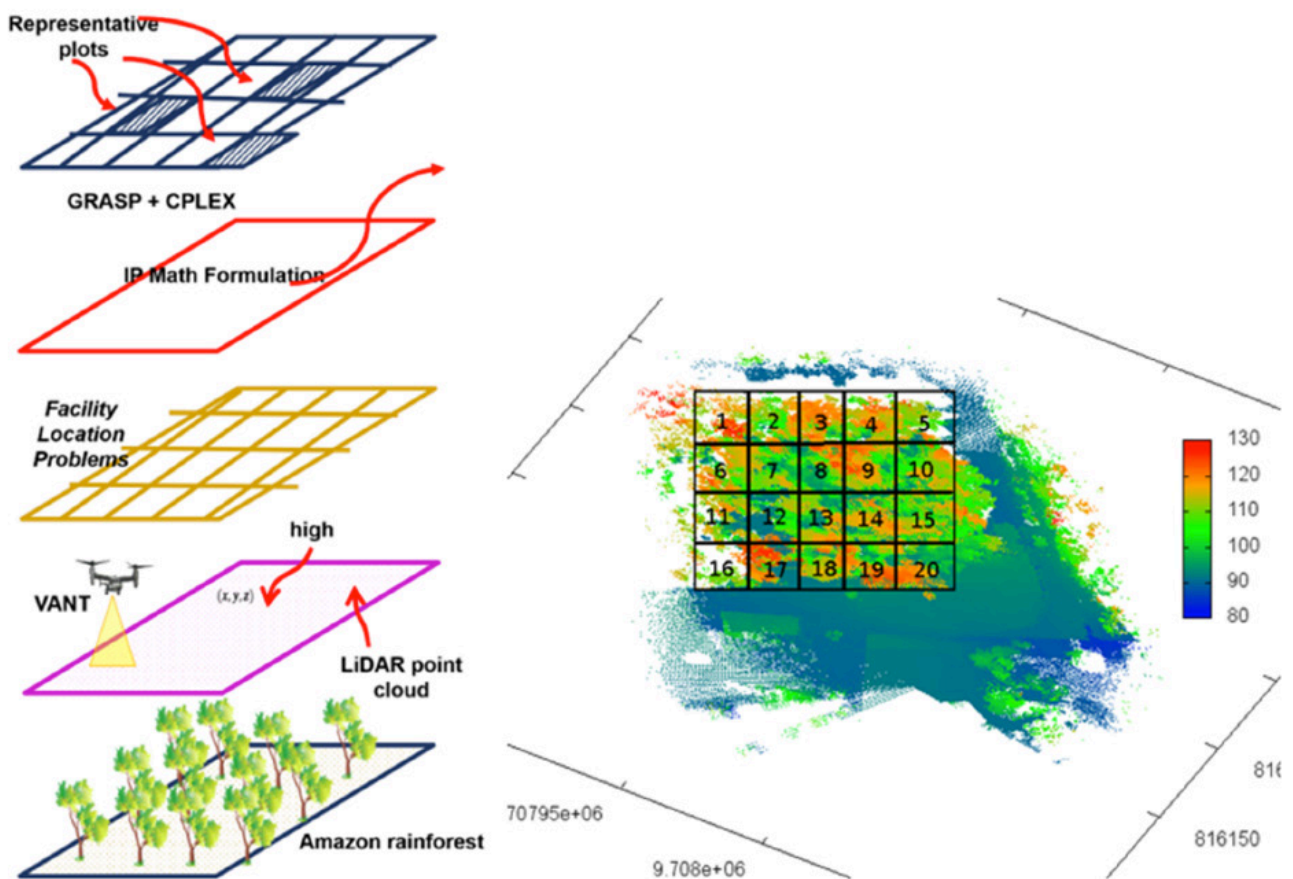




▲ Figure 03 – 3D high resolution remote sensing by LIDAR. Source: CADAF project.



▲ Figure 04 – (a) LIDAR point cloud of a segment of the Amazon rainforest. (b) DSM and DTM to calculate the average height of a segment of forest.



▲ Figure 05 – (a) Multilayer representation of the resolution strategy framework of the problem of determining the amount of carbon stored by a segment of the Amazon rainforest. Grid of a permanent plot (e.g. 20x125 meters). (b) LiDAR point cloud which was determined by discretizing remote sensing by UAV/LiDAR technique, applied in the INPA ZF-2 Experimental Reserve.



▲ Figure 06 – A satellite image example and its corresponding segmentation applying supervised ML (AI techniques).

### Automated Detection of Deforestation Areas in the Amazon Region using Remote Sensing and Machine Learning

This line of research addresses the problem of automated detection of deforestation areas in the Amazon Rainforest. We have proposed an approach for classifying remote sensing images, comprising three steps: 1) image segmentation, 2) feature extraction and 3) classification. Different techniques can be used in each one of these steps. Experiments were performed with several classification algorithms, seven supervised techniques: SVM, Decision Tree, Perceptron, Random Forest, Logistic Regression, KNN and Naive Bayes; and two unsupervised: K-Means and BIRCH. The goal is to find a classification model which best describes distinct patterns of deforestation in the images. We have worked with a set of satellite images (Landsat TM). These images are characterized by color and texture measurements that constitutes the features used for classification. The experiments performed used images from Barcelos - Amazonas State – Brazil, comprising 26 images divided in 3.288 segments with at least 700 pixels each. The corresponding ground truth dataset is made of 1636 clearing and 1652 no-clearing segments. Figure 06 presents an example of an image segmentation. Note that the segmentation roughly separates the areas with deforestation. This facilitates the classification step. There are 781 features per image segment. Figure 06 shows the results for the supervised and unsupervised techniques, respectively. The decision tree technique reached accuracies of 97.18 and 97.65 for deforestation and no-deforestation segments, respectively. The unsupervised approaches (K-means and BIRCH) reached accuracy of approximately 95% for both deforestation and no-deforestation segments.

### Acknowledgements

Our thanks to all researchers and students who were involved in some stage of this work, the result of several R&D projects, partially supported by the Brazilian development agencies, CNPq, CAPES, FINEP, FAPESP.

### References

CHURCH, R. & REVELLE C. The maximal covering location problem. *Papers of the Regional Science Association*, 32, 101–118, 1974.

GAUI, T.; COSTA, F., C., F.; AMARAL, M.; CARVALHO, D.; REIS, F.; HIGUCHI, N. Long-term effect of selective logging on floristic composition: A 25-year experiment in the Brazilian Amazon. *FOREST ECOLOGY AND MANAGEMENT*, v. 440, p. 258-266, 2019.

FARAHANI, R. Z. et al. (2012). Covering problems in facility location: A review. *Computer and Industrial Engineering*, vol 62 issue 1 (368-407).

FREITAS, R. de, CAVALCANTE, J. M., CLEGER, S., HIGUCHI, N. Detection of Clearing Areas in the Amazon Forest Through Satellite Monitoring using Machine Learning Techniques. *Annals of 2019 Informatics International Conference*. Cancun, Mexico, 2019.

FREITAS, R. de; CAVALCANTI, J.M.; CLEGER, S.; HIGUCHI, N.; CELES, C.H.; LIMA, A. Estimating Amazon Carbon Stock Using AI-based Remote Sensing. *Communications of the ACM*, Vol. 63 No. 11, Pages 46-48, 2020.

FREITAS, R. de; GEMAQUE, R. N. ; SILVEIRA, D. D. B. ; HIGUCHI, N. . Estimating the carbon stocks by optimizing LiDAR forest big data. *eScience Workshop*, 2018.

FREITAS, R. de. Optimization of Forest Big Data – Estimating tropical forest carbon stocks using 3D high-resolution remote sensing for large scale mapping. *Microsoft Research Faculty Summit*. Viña del Mar, Chile, 2016.

JUNTILA, V. et al. (2013). Strategies for minimizing sample size for use in airborne LiDAR-based forest inventory. *Forest Ecology and Management*, 292: 75 – 85.

PESSOA, M. ; MELO, R. ; RODRIGUES, A. ; CLEGER, S. ; CAVALCANTI, J. M. ; de Freitas, R. . Detecção de áreas de clareiras na Floresta Amazônica através de monitoramento via satélite usando técnicas de aprendizagem de máquina. In: *XLVI Seminário Integrado de Software e Hardware (SEMISH-CSBC 2019)*, 2019, Belém-PA. *Anais do XLVI Seminário Integrado de Software e Hardware, Congresso da Sociedade Brasileira de Computação*. Porto Alegre - RS, 2019. v. 1. p. 125-136.

SOUZA, C.; AZEVEDO, C.; ROSSI, L. SANTOS, J.; HIGUCHI, N. Carbon stock and dynamics in a managed forest in Central Amazon. *Scientia Forestalis*, v. 46, p. 427-436, 2018

RESENDE, M. G. C. Computing Approximate Solutions of the Maximum Covering Problem with GRASP. *J. Heuristics* 4(2): 161-177, 1998. 🌐





▲ Marianna De Santis

# Challenges in Solving Multiobjective Mixed Integer Nonlinear Problems

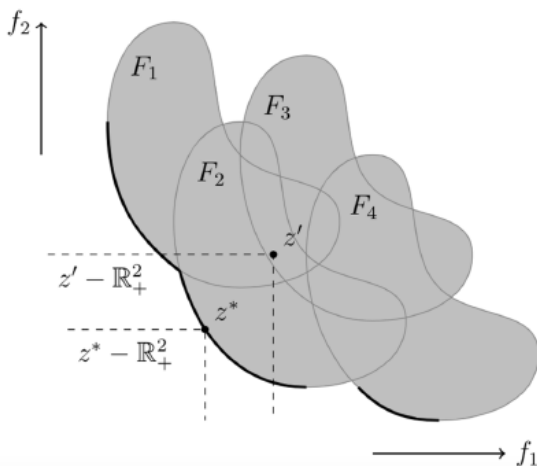
**Marianna De Santis** <marianna.desantis@uniroma1.it>

Most real-world optimization problems in the areas of applied sciences, engineering and economics involve multiple, often conflicting and nonlinear, goals. In the mathematical model of these problems, under the necessity of reflecting discrete quantities, logical relationships or decisions, integer and 0-1 variables need to be introduced, leading to MultiObjective Mixed Integer Nonlinear Programming problems (MO-MINLPs). The practical relevance of MO-MINLPs is pointed out in many publications, where tailored approaches for specific applications have been proposed. We mention works on finance, management, transportation, design of water distribution networks, biology [8, 9, 13, 14, 15]. MO-MINLPs are intrinsically nonconvex, implying that the design of exact and efficient solution methods is particularly challenging and requires global optimization techniques [6].

A general MO-MINLP can be formulated as follows

$$\begin{aligned} \min \quad & (f_1(x), \dots, f_m(x))^T \\ \text{s.t.} \quad & g_k(x) \leq 0 \quad k = 1, \dots, p \\ & x_i \in \mathbb{Z} \quad \forall i \in I, \end{aligned} \quad (\text{MO-MINLP})$$

where  $f_j, g_k : \mathbb{R}^n \rightarrow \mathbb{R}$ ;  $j = 1, \dots, m$ ;  $k = 1, \dots, p$ , and the index set  $I \subseteq \{1, \dots, n\}$  specifies which variables have to take integer values. In the following, we denote by  $\mathcal{F} = \{x \in \mathbb{R}^n \mid g_k(x) \leq 0 \quad k = 1, \dots, p; x_i \in \mathbb{Z} \quad \forall i \in I\}$  the feasible set of problem (MO-MINLP). The image of the feasible set of the problem under the vector-valued function  $f : \mathbb{R}^n \rightarrow \mathbb{R}^m$  represents the feasible set in the *criterion space*, or the *image set*. In multiobjective optimization one looks for the so called *efficient solutions*. Those are feasible points such there exists no other feasible point for which  $f_j(x) \leq f_j(x^*)$ ,  $j = 1, \dots, m$  and  $f(x) \neq f(x^*)$ . The images  $f(x)$  of efficient points  $x \in \mathcal{F}$  are called *non-dominated points*. Solving (MO-MINLP) exactly means to detect its complete set of non-dominated points, also called the *non-dominated set* or *Pareto front* and its complete set of efficient points, also called the *efficient set*. In Figure 1 (see also [4]), we plot the image set of a bi-objective mixed integer nonlinear optimization instance. We assume that the feasible set is made of points  $x \in \mathbb{R}^n$  obtained fixing  $x_I$  to four different vectors:  $y^1, y^2, y^3, y^4 \in \mathbb{Z}^{|I|}$ .

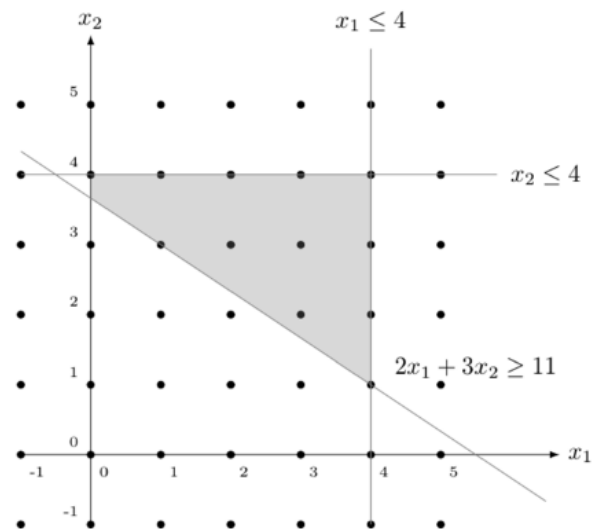


▲ Figure 1: Image set of a bi-objective mixed integer nonlinear optimization instance.

More precisely,  $\mathcal{F} = \{x \in \mathbb{R}^n \mid g_k(x) \leq 0 \quad k = 1, \dots, p; x_I \in \{y^1, y^2, y^3, y^4\}\}$ . The whole image set is the union of the sets  $F_j := \{f(x) \mid g_k(x) \leq 0 \quad k = 1, \dots, p; x_I = y^j, j = 1, \dots, 4\}$ , which are the image through  $f$  of feasible points where  $x_I$  is fixed to one of  $y^1, y^2, y^3, y^4 \in \mathbb{Z}^{|I|}$ . The non-dominated set (or the Pareto front) of the problem is visualized as the bold black line in the boundary of the image set. The efficient set is made of all preimages of the non-dominated set. Note that the point  $z^* \in f(\mathcal{F})$  is non-dominated and the preimage of  $z^*$  is an efficient point. On the other hand,  $z' \in f(\mathcal{F})$  is dominated because  $z^* \leq z'$  and  $z^* \neq z'$ . In fact, all the points  $z \in F_3$  are dominated, as points  $w \in f(\mathcal{F})$  exist such that  $w_i < z_i$  for  $i = 1, 2$ . Figure 1 shows that the non-dominated set of a MO-MINLP is in general a disconnected set.

From an algorithmic point of view, this makes the detection of the efficient set of an extremely

challenging problem, as sub-regions of the feasible set cannot easily be excluded a priori. This picture shows a crucial difference with respect to single objective mixed integer nonlinear optimization that is also pointed out in [1]. Assume that we have a single-objective mixed integer nonlinear programming problem having  $\mathcal{F}$  as feasible set. In order to solve this MINLP, one can think of comparing the solutions obtained by addressing four nonlinear programming problems, where the integer variables  $x_i$ ,  $i \in I$  are fixed to  $y^1, y^2, y^3, y^4 \in \mathbb{Z}^{|I|}$ , respectively. The optimal solution can then be recovered from a specific fixing of the integer variables. In the multiobjective context, following the same strategy would mean to address four multiobjective nonlinear programming problems, get their own non-dominated sets and then apply a filtering procedure, >>



▲ Figure 2: the image set of the instance reported in [5], example 8.6.

>> able to compare the sets of points obtained and detect the non-dominated set of the original problem. Note that we are not guaranteed that the non-dominated set is obtained fixing the integer variables  $x_i, i \in I$  to a single  $y_j, j = 1, \dots, 4$ . This highlights the challenges in devising exact methods for MO-MINLPs.

A classical approach in multiobjective optimization is scalarization: the problem is reformulated in order to deal with a single-objective. For instance, one might consider a weighted-sum of the objectives and minimize that function over the feasible set. However, by doing that not all efficient solutions of (MO-MINLP) can be found due to the non-convexity coming from the integrality constraints. An example in this respect is the one given by Ehrgott (see [5] (example 8.6)), that we report here:

$$\min_{x \in X \cap \mathbb{Z}^2} (x_1, x_2),$$

where  $X$  is defined as  $X = \{x \in \mathbb{R}^2_{\geq 0} | 2x_1 + 3x_2 \geq 11, x_1 \leq 4, x_2 \leq 4\}$ . The image set of this bi-objective integer linear problem, that is the same as the pre-image set since the objectives are  $(x_1, x_2)$ , is represented in Figure 2. The non-dominated set is made of four points:  $\{(0, 4); (1, 3); (3, 2); (4, 1)\}$ . Note that in this case the problem is purely integer and then the non-dominated set is finite. As pointed out in [5], point  $(3, 2)$  cannot be obtained as a solution of a weighted-sum problem and then this scalarization is not sufficient to detect the complete non-dominated set of a (MO-MINLP), even when assuming that it is a finite set.

Another classical possibility to deal with multiobjective optimization problems is to minimize one among the objective functions and transform the others into constraints depending on specific parameters. Beside the difficulties of properly choosing the values for the parameters, when dealing with MO-MINLPs, in order to obtain a representation of the efficient set, one faces the difficulty of addressing a sequence of single-objective mixed integer nonlinear problems. Furthermore, this approach cannot give guarantees in detecting the efficient set of a MO-MINLP according to a prescribed accuracy.

Regarding general purpose methods able to give correctness guarantees, the focus is most of all on multiobjective mixed integer linear problems (MO-MILPs) and we refer to [10] for a survey. A first class of algorithms developed for MO-MILPs, is the class of the so called *criterion space search algorithms*, i.e., algorithms that work in the space of the objective functions (the image or criterion space). Such algorithms find non-dominated points by solving a sequence of single-objective MILPs. After computing a non-dominated point, these algorithms remove the dominated parts of the criterion space (based on the obtained non-dominated point) and look for not-yet-found non-dominated points in the remaining parts. This class can be extended to deal with nonlinear problems, even if this clearly adds difficulties both from a theoretical and a numerical point of view. In the bi-objective purely integer case, an approach that can be followed to deal with nonlinearities is the one in [2], where a criterion space search algorithm to detect the complete Pareto front has been proposed. A limit of criterion space search algorithms is their difficulty in handling more than two objective functions. Attempts to overcome this issue have been recently made in the context of purely integer problems, assuming a finite non-dominated set [7, 11, 12]. However, when dealing with more than two/three objectives, *decision space search algorithms*, i.e., algorithms that work in the space of variables (or preimage space), turn out to be more appropriate in case the number of variables is not too large and the functions involved are convex. For multiobjective mixed integer convex programs, deterministic algorithms able to guarantee correctness in terms of detecting both the efficient and the non-dominated set according to a prescribed precision have been recently devised [3, 4]. However, literature on general purpose exact methods for MO-MINLPs is still very limited and we hope that this tutorial may contribute in raising interest on this topic.

## References

- [1] G. Cabrera-Guerrero, M. Ehrgott, A.J. Mason and A. Raith. Bi-objective optimisation over a set of convex sub-problems. *Annals of Operations Research*, 2021. <https://doi.org/10.1007/s10479-020-03910-3>
- [2] M. De Santis, G. Grani and L. Palagi. Branching with hyperplanes in the criterion space: The frontier partitioner algorithm for bi-objective integer programming. *European Journal of Operational Research*, 283(1):57–69, 2020.
- [3] M. De Santis, G. Eichfelder. A Decision Space Algorithm for Multiobjective Convex Quadratic Integer Optimization. *Computers and Operations Research*, 134, 2021. <https://doi.org/10.1016/j.cor.2021.105396>
- [4] M. De Santis, G. Eichfelder, J. Niebling, S. Rocktäschel. Solving multiobjective mixed integer convex optimization problems. *SIAM Journal on Optimization*, 30(4):3122–3145, 2020.
- [5] M. Ehrgott. Multicriteria optimization. *Springer Science & Business Media*, 491, 2005.
- [6] G. Eichfelder. Twenty Years of Continuous Multiobjective Optimization. [http://www.optimization-online.org/DB\\_HTML/2020/12/8161.pdf](http://www.optimization-online.org/DB_HTML/2020/12/8161.pdf)
- [7] T. Holzmänn and J. Cole Smith. Solving discrete multi-objective optimization problems using modified augmented weighted Tchebychev scalarizations *European Journal of Operational Research*, 271(2), 436–449, 2018.
- [8] A. Legendre, E. Angel and F. Tahi. Bi-objective integer programming for RNA secondary structure prediction with pseudoknots. *BMC Bioinformatics* 19, 13, 2018.
- [9] A-J. Ulusoy, F. Pecci, E. Abraham and I. Stoianov. Bi-objective design-for-control of water distribution networks with global bounds. *Optimization and Engineering*, 2021. <https://doi.org/10.1007/s11081-021-09598-z>
- [10] A. Przybylski and X. Gandibleux. Multi-objective branch and bound. *European Journal of Operational Research* 260(3): 856–872, (2017).
- [11] S. Tamby and D. Vanderpooten. Enumeration of the non-dominated set of multi-objective discrete optimization problems. *INFORMS Journal on Computing* 33(1): 72–85, (2021).
- [12] O. Turgut, E. Dalkiran, and A.E. Murat. An exact parallel objective space decomposition algorithm for solving multi-objective integer programming problems. *Journal of Global Optimization*, 75(1): 35–62, (2019).
- [13] P. Xidonas, G. Mavrotas and J. Psarras. Equity portfolio construction and selection using multiobjective mathematical programming. *Journal of Global Optimization*, 47, 185–209, 2010.
- [14] M. M. Yenisey and B. Yagmahan. Multi-objective permutation flow shop scheduling problem: Literature review, classification and current trends. *Omega*, 45, 119–135, 2014.
- [15] H. Zhong, W. Guan, W. Zhang, S. Jiang and L. Fan. A bi-objective integer programming model for partly-restricted flight departure scheduling. *PLoS ONE* 13(5): e0196146, 2018. 🌐

# Optimising National Grid UK Electricity Transmission Assets with the Copperleaf Decision Analytics Solution

Stefan Sadnicki, Copperleaf <ssadnicki@copperleaf.com>

## Background

**National Grid Electricity Transmission (NGET)** owns and manages the distribution of electricity throughout the UK, which includes in excess of 60,000 assets. These include the familiar towers (pylons) supporting the cables which carry the electricity around the UK, plus associated circuit breakers, instrument transformers, grid transformers, and more. Maintaining the performance of these assets is an investment plan worth between £800 million and £1 billion a year, so the value of effective optimisation is very high.

Because the assets deteriorate over time, they need to be taken out of service for maintenance and/or refurbishment at regular intervals. This results in a loss of supply (outage) for the circuit containing that asset, which can be very costly. However it is possible to service more than one asset at the same time in a given circuit, a process called bundling, which will reduce the number of outages and hence the cost incurred.

Every outage comes with an associated direct and indirect cost. Outages must also be carefully coordinated so as not to disrupt the electricity transmission network. For example, it might be determined that out of a set of four circuits, only one may be taken out within a one-year period.

Since each intervention also requires resources, such as personnel and spare parts, the planners must schedule these at a time when they are available. So the technical challenge is to find the optimal intervention schedule for each asset in the transmission network, while considering the benefits of bundling gains, the outage costs and resource constraints, plus any relevant business rules.

**Copperleaf** has its headquarters in Vancouver and provides decision analytics to companies facing the challenges of managing critical infrastructure. Their enterprise software solutions leverage operational, financial and asset data to empower their clients to make investment decisions that deliver the highest business value. This project was carried out by their UK-based team.

## The Solution

Historically, the planning process had been manual, relying on



▲ Fig 1 Electricity transmission tower asset

a planner using his/her experience to recognise potential bundling opportunities, then building all the resource and outage requirements together into a deliverable package. However, these solutions could not take account of the non-linear calculations involved in estimating outage durations, since each viable solution will result in a different level of outage. This is a disadvantage of the manual approach.

NGET and Copperleaf worked together to find improved solutions by combining the power of Copperleaf's Decision Analytics Solution and its consulting and software development expertise, together with the engineering knowledge and prototypes that had been nurtured within NGET over the years. This partnership developed a novel approach based on breaking down the optimisation process into a series of steps.

The novel 4-Step solution process is summarised in Fig 2. The steps are:

**Step 1: Asset Level Value Model.** This considers for each asset:

- The monetised risk, which is calculated from asset history, asset age, network risk, and failure mode analysis data. In effect this is the probability and cost of this asset failing
- up to 8 types of intervention per asset, such as basic/intermediate/major maintenance; minor/major refurbishments; and replacement of the entire asset or individual components.
- lifecycle costs and value (in terms of risk mitigation) of various intervention schedules e.g. basic, refurbish, replace on a 5-year cycle etc.

The output from this step is a set of alternative interventions, each one assuming that the resources are available but without considering the impact of outage.

**Step 2: Circuit Optimisation.** Each circuit contains several assets and the aim is to optimise the cost of interventions with different constraints (such as the availability and location of specialist staff) whilst incorporating bundling opportunities to reduce outages. Because each circuit is relatively small it is possible to express this problem as a Mixed-Integer Linear Programme (MILP) and come up with optimal bundled solutions for each circuit quickly.

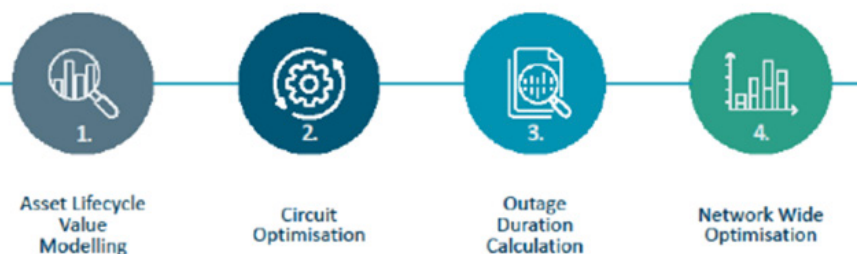
**Step 3: Outage Duration Calculation.** The Outage Duration for each of the bundled solutions is computed.

**Step 4: Network Wide Optimisation.** In this optimisation, each of the Bundled Solutions computed in step 2 are considered and the network wide outage and resource constraints are incorporated. >>





>> Because the Bundling Gains are already computed in Step 2, and because the non-linear outage duration is calculated as part of Step 3, it is possible to express the problem as a Mixed-Integer Linear Program problem that can be solved, even for a very large network, in a reasonable amount of time.



▲ Fig 2 The 4-Step Solution Process

This multi-step approach enabled a network wide optimisation involving more than 60,000 assets, considering over 5000 interventions per year, 50 teams each with up to 5 different resource types and 100 overlapping boundaries for circuit constraint management. The solutions produced have been validated by industry experts and it is believed that this problem has not previously been solved in the electrical transmission industry. A patent application for the multi-step technique is in progress.

## Implementation

Once NGET managers could see the potential benefits from the new optimised solution they decided to embed it as a central part of their standard asset investment planning process.

While the prototype algorithm was developed using Python scripting, NGET made a conscious decision to implement the finished solution using a commercial off-the-shelf software package. The Copperleaf solution integrates asset, maintenance and investment data from existing enterprise systems, thus automating the data input process through eight programmatic integrations which run either:

- nightly (to import updated asset data, for example)
- monthly (to bring in existing investments that are fixed in the schedule, such as a commitment to connect a new customer)
- or ad hoc (to update risk model inputs, for example).

Monetised risk, asset intervention planning, and circuit optimisation can now be handled together in one simple, centralised platform. Instead of having to work with five different tools or spreadsheets, NGET planners can now find everything they need on a single screen in the Copperleaf solution. This has also helped to identify long-term resource requirements and pinch points across the network, where NGET needs to recruit and build resource capacity.

Training was provided to distinct teams within NGET to support their individual use cases:

- Enterprise Asset Management Lifecycle Team:
  - o Optimise asset replacement plans subject to risk and cost constraints
- Network Interventions Team:
  - o Optimise full lifecycle asset plans subject to cost, risk, and planned work
- Delivery Optimisation Team:
  - o Optimise plans subject to team, zone, and national resource constraints
- Network Optimisation Team:
  - o Optimise national plans subject to cost, resource and outage constraints

Enhanced asset lifecycle modelling has led to improved risk management, as well as ensuring that NGET selects the right interventions, at the right time, at the right cost for consumers.

The solution is now managed internally within National Grid with ongoing support provided by Copperleaf which includes membership of the Copperleaf client community and regular product upgrades and releases.

## Benefits

The new system went live in September 2019 and quickly delivered significant benefits, such as:

- a simple **Centralised Platform:** for monetised risk, asset intervention planning and circuit optimisation, now one screen, instead of having to look at 5 different tools or spreadsheets.
- Improved **Planning Efficiency:** by reducing the time to build the plan for the fiscal year 2022 by 50% (from 12 weeks to 6 weeks). The increased agility and speed to carry out what-if analysis has been particularly important as NGET had to deconstruct the initial plan and rebuild it under different scenarios through the course of the COVID-19 pandemic.
- **Reduction in Outage Costs of £2.5m / year:** The Copperleaf solution has reduced outage requirements across the network – for example, the number of circuits requiring an outage 3 times in a 5-year period has reduced from 18% to just 8%. Specifically, compared to manual bundling, the Copperleaf solution optimisation for the Financial Year 2021 plan has increased the “Bundling Ratio” (number of interventions per outage) by 66%.
- **Higher Value Plans:** enhanced asset lifecycle modelling has led to improved risk management and ensured that National Grid selects the right interventions at the right time and the right cost for consumers.
- **Strategic Workforce Planning:** The output from the Copperleaf optimiser has also provided greater visibility into long-term resource requirements and pinch-points across the network where there is a requirement to recruit and build resource capacity.

## Endorsements

**“This is the most complex optimisation problem Copperleaf has ever solved.** It recently won the Copperleaf 2020 Innovation Award, voted on by all Copperleaf clients globally.” Stan Coleman, Chief Technology Officer, Copperleaf

**“The circuit optimisation solution is underpinned by a cutting-edge and complex algorithm that was co-developed with Copperleaf. This is helping NGET further improve our ability to anticipate and manage asset risks, ensuring we continue to make the right investment decisions across our network.”**

David Wright, Group Chief Engineer, National Grid

This project was the runner up in the OR Society’s President’s Medal competition in 2020 and won the Innovation Award in the Institute of Asset Management (IAM) Global Awards 2020. 🌍

# Gender Diversity in the World

Grazia Speranza <grazia.speranza@unibs.it>

In June 2020, during the first planetary lockdown caused by the pandemic, IFORS organized the first webinar of the IFORS Global Webinar Series. Several others followed that first event, with a bimonthly frequency. The first four webinars had some of the best speakers from each of the four groupings of the national member societies of IFORS (ALIO, APORS, EURO, NORAM). The fifth webinar celebrated AFROS, the African operations research community.

The sixth IFORS global webinar took place on June 29, 2021, one year after the first, and, instead of being focused on a community as all the previous webinars, was focused on a topic. The title, Gender Diversity in the World: Initiatives and Issues in the O.R. Community, is self-explaining. The topic of gender diversity has had in the last years a high priority in the agendas of national and international institutions worldwide. The global reach of IFORS and its community made it a natural candidate for an IFORS global webinar.

The webinar had four speakers, one for each of the four regional groupings, each introduced by the IFORS Vice-President representing that region

- **Luciana Salete Buriol**, from the Federal University of Rio Grande do Sul (Brazil), was introduced by Rosiane de Freitas (ALIO Vice-President);
- **Guiying Yan**, from the Academy of Mathematics and Systems Science, Chinese Academy of Sciences (China), was introduced by Sunity Hada (APORS Vice-President);
- **Paula Carroll**, from the University College Dublin (Ireland), was introduced by Claudia Archetti, who replaced Stefan Nickel (EURO Vice-President);

- **Olga Perdikaki**, from the University of South Carolina (USA), was introduced by Karla Hoffman (NORAM Vice-President).

After an introduction to the topic of gender diversity I gave, the four speakers discussed the situation in their respective regions. A lively discussion followed their presentations. At <https://www.ifors.org/ifors-global-webinar-series/> the recording of all the webinars is available. I invite you to have a look at it. The IFORS global webinar series has been very successful. Keep an eye on the new webinars that will be organized after the summer break. 🌐



Global Webinar Series

### Gender Diversity in the World: Initiatives and Issues in the O.R. Community

June 29, 2021  
9:00 am Washington DC/ 3:00 pm Rome /9:00 pm China

**Hosts**  
Grazia Speranza, Italy (IFORS President); Rosiane de Freitas (ALIO Vice-President),  
Sunity Hada (APORS Vice-President), Claudia Archetti (EURO Host),  
Karla Hoffman (NORAM Vice-President)

**Register for this free webinar on the IFORS website: [www.ifors.org](http://www.ifors.org)**

**Invited Speakers:**



**Luciana Salete Buriol**  
Federal University of Rio Grande do Sul (UFRGS), Brazil



**Guiying Yan**  
Academy of Mathematics and Systems Science,  
Chinese Academy of Sciences (CAS)



**Paula Carroll**  
University College Dublin, Ireland



**Olga Perdikaki**  
University of South Carolina, USA

Several times each year, IFORS will offer free webinars on topics of key interest to those developing and applying operational research and analytics methodologies and models.





## From Genome Mining, Wildfire Detection, to Digital Marbling Art - Collaboration in Science, High-tech and OR for Development in Banda Aceh, Indonesia, and Online

**Vera Halfiani** <verahalfiani@unsyiah.ac.id>, **Marwan Ramli** <marwan.math@unsyiah.ac.id>



▲ ICST 2021 welcoming banner presenting the keynote speakers: *Prof. Taifo Mahmud* (Oregon State University, USA), *Dr. Peter Woodfield* (Griffith University, Australia), and *Prof. Gerhard-Wilhelm Weber* (Poznan University of Technology, Poland).

The International Conference on Science and Technology (ICST) is an annual event held by the *State Higher Education Cooperation Agency of the Western Region of Indonesia in the Fields of Mathematics and Natural Sciences* (known as “BKS PTN Wilayah Barat Indonesia bidang MIPA” in Bahasa). In 2021, it was the fourth time that this conference was held. This year, the event was hosted by the Faculty of Mathematics and Natural Sciences, *Universitas Syiah Kuala*, Banda Aceh, Indonesia. Due to the restrictions during the COVID-19 pandemic that was still happening, the conference was carried out virtually through an online meeting platform. It took place on July 3, 2021. Despite that situation, it did not whittle away the enthusiasm of the participants. About 250 participants from academic and government institutions actively engaged in the knowledge exchange. The public can access the details about the conference through its website at <http://icst.unsyiah.ac.id/>. The information can also be found on the *IFORS* website at <https://www.ifors.org/the-4th-international-conference-on-science-and-technology-icst-2021/>.

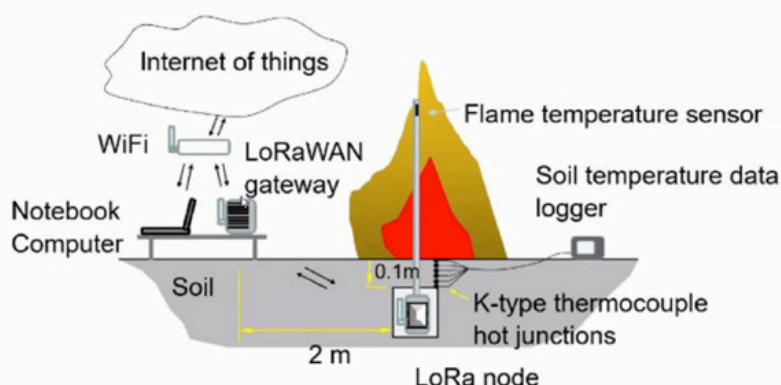
The theme of the ICST 2021 was “*Science for Excellence Development of Local Natural Resources*”. To support this idea, the organizing committee invited three keynote speakers from various expertise. The speakers were *Prof.*

*Taifo Mahmud*, *Dr. Peter Woodfield*, and *Prof. Gerhard-Wilhelm Weber*. The topics that the speakers presented provided insights and recent studies covering the fields of natural sciences, mathematics, and technology. The implementation of big data, artificial intelligence, mathematical models as well as *Operational Research* (OR) gave highlights to the presentations.

The first keynote speaker was *Prof. Taifo Mahmud* from the Department of Pharmaceutical Sciences, Oregon State University, USA. His talk was about “*Recent Advances and Innovations in Natural Product Research*”. As more traditional ways were no longer sufficient in terms of bioactive compound discovery, the use of advanced technology and new approaches was essential in producing potential medicine in bioactive compounds. The discovery of new resources was also the main aspect of natural product research. Concerning the new resources, bioactive compounds from diverse ecosystems in Indonesia were analyzed. Advanced technologies, instrumentations, and approaches had changed the way scientists conducted researches. Biotechnology had revolved through implementing big data into the study such as in genome mining. This method may accelerate the discovery of natural products.



## Indestructible Wildfire Sensing



Griffith School of Engineering, Qld, Australia

▲ ICST 2021: Wildfire detection sensor as the implementation of transient thermal penetration concept.

The next speaker was Dr. Peter Woodfield from the School of Engineering and Built Environment, Griffith University, Australia. The topic of his speech was “*Transient Thermal Penetration, Thermomagnetic Convection, and Indestructible Wildfire Sensing*”. Heat conduction expressed in partial differential equations was the basis of understanding the transient thermal penetration. He pointed out how the Fourier number played an important part in indicating the depth of the penetration of the heat into the solids. This approach was also applicable to the measurement of the thermal conductivity of fluids. Furthermore, an interesting thermal behavior was also observed in ferrofluids, colloid suspensions of magnetic nanoparticles in a base fluid such as water or oil. The concept of transient thermal penetration can be applied to the design of dynamic thermal boundaries, for example, to a wildfire detection sensor. The sensor can be placed at a certain depth under the surface of the soil so that it can survive the intense heat of the fire.

Last but not least a keynote speech was presented by Prof. Gerhard-Wilhelm Weber from Poznan University of Technology, Poland. He gave an account of “*Classification and Generation of Digital Marble Art (Ebru) by Revisiting Operational Research (OR) via Deep Learning*”. Ebru is the Turkish art of marbling. It is a traditional art of producing colorful patterns or designs on water using color pigments and unique tools then transfer them onto sheets of paper or fabric.

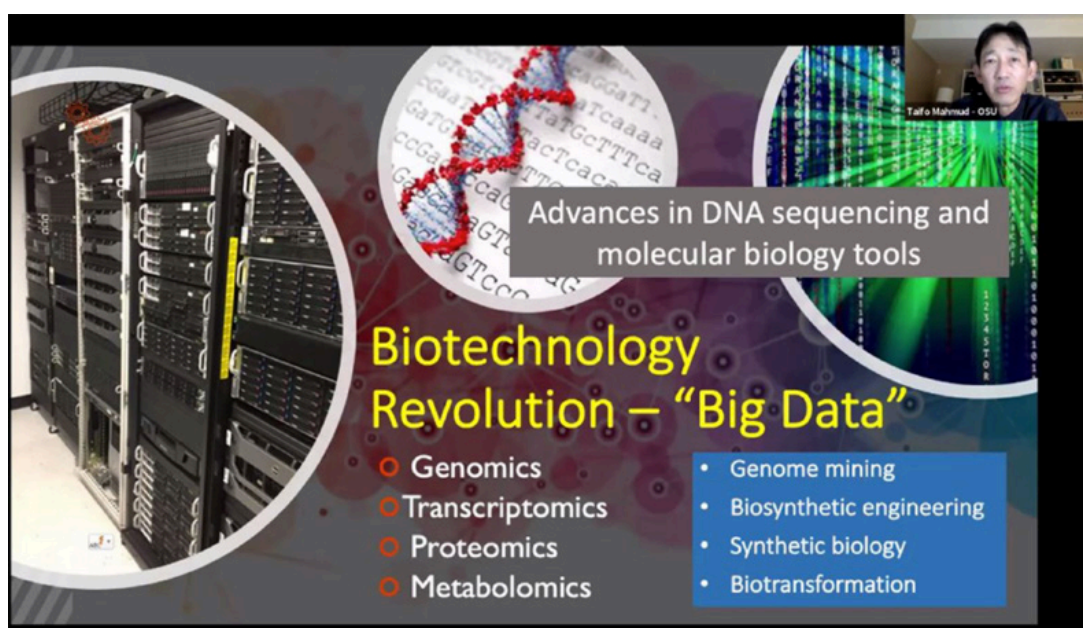
The process of generating

digital marble art made use of artificial intelligence. This was the opposite of the inverse problem on image processing where an image was classified or reconstructed. The generative process was known as the forward problem. A new Generative Adversarial Network (GAN) framework and a big dataset to test the reconstructed work were proposed. The idea of the study was based on the certain Support Vector Machine (SVM) with the convolution of Convolutional Neural Network (CNN). This was where mathematical optimization played a part. SVM usually used linear, nonlinear, or Radial Basis Function (RBF) kernels to test CNN. Utilizing an OR

approach, a general model which can generate appealing art pieces without human supervision, was developed.

In the marbling art generation, Deep Convolutional Generative Adversarial Network (DCGAN) with two convolutional layers was presented. These layers were modified into kernel convolution (kervolution) structures by adding kernel operations to increase nonlinearity. Some types of kernels such as linear, polynomial, and Gaussian RBF kernels were used to test the kervolution.

Finally, an insight into how OR researchers work together with science and technology would promote interdisciplinary studies. Mathematical modeling may be applied as a powerful tool for the enhancement of technology, such as the use of OR in the artificial neural network. This can open new possibilities for the development of science and its applications in human life. 🌐



▲ ICST 2021: Advances in Biotechnology which utilized big data.



# EUROPT Workshop 2021: Celebrating the 20th anniversary by enjoying Continuous Optimization online

**Sonia Cafieri** <sonia.cafieri@enac.fr> **Nicolas Couellan** <.nicolas.couellan@enac.fr>

**Sophie Jan** <sophie.jan@math.univ-toulouse.fr> **Frederic Messine** <frederic.messine@laplace.univ-tlse.fr>

**Giancarlo Bigi** <giancarlo.bigi@unipi.it>

The 18th edition of the annual conference of *EUROPT*, the *EURO Working Group on Continuous Optimization*, the *EUROPT Workshop on Advances in Continuous Optimization -- EUROPT 2021* – has been held virtually from July 7 to 9, 2021, organized from Toulouse, France, and hosted at ENAC - Ecole Nationale de l'Aviation Civile: <https://europt2021.recherche.enac.fr/>.

Since 2000, this conference has been held every year (except for 2002, -05, -08 and -20) in a European city (except for the 2011 and -17 editions which took place in Ballarat, Australia, and Montreal, Canada), and is one of the major events in the European mathematical optimization community. In 2020, the conference was expected to take place at *ENAC*, Toulouse, but due to the COVID-19 pandemic, the Organizing Committee and the *EUROPT* Managing Board decided to postpone it to 2021 while maintaining its original location. The evolution of the situation and the difficulties that persist in international travels, have finally led to the choice of a virtual format.

This edition has then been really special in many ways: for the first time, the event has been held in a fully virtual format, and for the first time attendance has been free of charge, thanks to the support of sponsors. Despite the format change, the Organizing Committee worked to set up an event promising to be a not-to-miss opportunity for stimulating (virtual) discussions on the latest developments in continuous optimization.

The Program Committee, chaired by *Sonia Cafieri* (ENAC, Toulouse), was composed by 31 *EUROPT* members, including the *EUROPT* Managing Board, as well as some *EUROPT* Fellows and *EUROPT* Past and Honorary Chairs. The Organizing Committee was composed by 4 members from Universities in Toulouse, France (ENAC, Institut de Mathématiques de Toulouse, and LAPLACE-INPT-ENSEEIH) plus a staff member of ENAC for administrative support.

Registered participants were 295 from 37 countries, with the geographical distribution depicted in the figure. Among these participants, 68 were graduate students.

Every year, the *EUROPT* Working Group honors outstanding researchers in continuous optimization by awarding the *EUROPT Fellowship*. The Fellowship is presented to the awarded researcher at the *EUROPT Workshop*, where the Fellow delivers the *EUROPT Fellowship Lecture* as a plenary talk. As a



▲ *EUROPT 2021*: its airy and atmospheric icon.

consequence of postponing the 18th *EUROPT Workshop* from 2020 to 2021, this special edition had the honor to award both the *EUROPT Fellow 2020* and the *EUROPT Fellow 2021*, who both delivered their lectures. The recipient of the 2020 *EUROPT Fellowship* was *Manlio Gaudioso*, Professor at the Università della Calabria, Italy, who delivered the *EUROPT Fellowship Lecture on Nonsmooth Optimization for Classification Problems in Machine Learning*. The recipient of the 2021 *EUROPT Fellowship* was *Monique Laurent*, Professor at the Centrum Wiskunde & Informatica, and Tilburg University, Netherlands, who delivered the *EUROPT Fellowship Lecture on Copositivity, sums of squares of polynomials and graphs*.

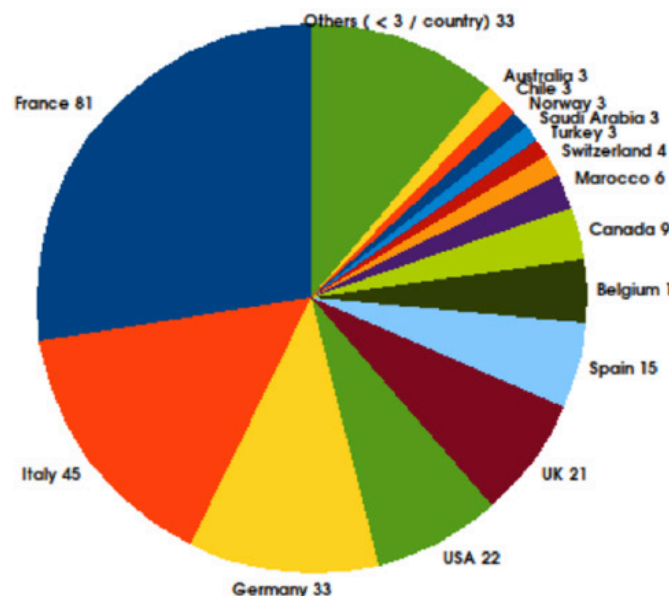
The conference started with an opening session on July 7, presided by the conference chair *Sonia Cafieri*, including welcome addresses by the hosting institution ENAC and by the *EUROPT WG* chair, and providing information on how the online conference would have been run. The scientific program consisted in exactly 200 talks covering all aspects of continuous optimization, and organized in invited and contributed streams. Parallel sessions grouped 3 or 4 talks, each on a timeslot of 25 minutes. Talks were held live, with ZOOM used for broadcasting live video and audio.

Beyond the two *EUROPT Fellowship Lectures*, two other *Plenary Lectures* were delivered by *Martine Labbé*, Professor at the Université Libre de Bruxelles, Belgium, on *Linear bilevel optimization: overview and recent results*; and *Oliver Stein*, Professor at the Karlsruhe

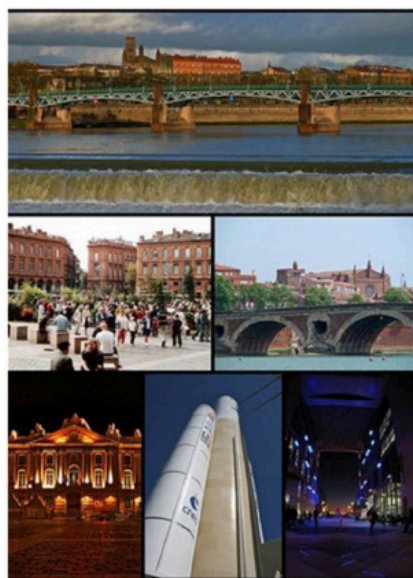
Institute of Technology, Germany, on *Granularity - a bridge between continuous and discrete optimization*.

*Social Program and EUROPT 20th birthday*

*EUROPT 2021* incorporated also a series of social events, held of course in a virtual format.



▲ *EUROPT 2021*: participation by countries.



Quiz by  
**J.-B. HIRIART-URRUTY**  
(JBHU)

TOULOUSE, July 7-9, 2021



#### ▲ EUROPT 2021: Social events held on July 7 and July 8.

These events included a celebration of the 20 years of activity of the EUROPT working group. The anniversary was actually in 2020, a year unfortunately marked by the COVID-19 pandemic with none of the EUROPT activities taking place. Hence, we celebrated this important milestone on the occasion of the 2021 online workshop. *Gerhard-Wilhelm Weber* - one of the three Honorary Chairs of EUROPT, along with *Tamas Terlaky* and *Tibor Illés* - presented an historical perspective on July 7: *EUROPT 20th birthday: a flashback*. As a gift for this anniversary, we prepared a booklet that trace the history of EUROPT, that can be downloaded from the conference website.

On July 8, participants could get together for a virtual social event, on an original idea by *Jean-Baptiste Hiriart-Urruty*: An

*online quiz*. The questions (about a dozen) were about sports or festive events; comparative life habits in different European countries; a bit of mathematics (optimization, of course). A daily virtual panel game was also organized. Participants were asked a few short questions by *Jean-Baptiste Hiriart-Urruty*. This was just to excite curiosity, and to distract the participants from the technical and specialized mathematics they had to follow during the conference.

EUROPT 2021 provided a strong evidence that, despite the difficulties of the pandemic situation, the EUROPT community is well alive, has the pleasure to contribute to advance Continuous Optimization, as well as the pleasure to get together and share the most recent advances. 🌐

## EURO 2021: A successful hybrid conference held online and on site at University of West Attica, Athens, Greece

**Rudolf Vetschera** <rudolf.vetschera@univie.ac.at> **Nikolaos Matsatsinis** <nmatsatsinis@isc.tuc.gr>

The EURO-k conferences organized jointly by EURO, the Association of European OR Societies, and national host societies, are the largest and most important OR conferences in Europe and among the largest OR conferences in the world. They are held annually except in years of IFORS conferences.

EURO 2021 was the 31st EURO conference and was jointly organized by EURO and HELORS, the Greek OR Society. For the first time in the history of EURO-k conference, due to the COVID-19 pandemic, the conference was held in a hybrid format, which combined an on-site part at the University of West Attica in Athens, Greece, and an online part, on July 11-14, 2021. Of the 1830 papers presented at the conference, 310 were presented on site, the rest online. With over 2000 registered participants, the conference was a bit smaller than previous EURO-k conferences, but still exceeded earlier expectations. This rather large attendance clearly shows that there is still a high demand for large international conferences as a forum to exchange ideas and learn about new developments in the field.

The decision about the conference format had to be made under great uncertainty, and for a long time it was not clear whether an on-site part of the conference could take place at all. Therefore, deadlines for submissions and for selecting the type of participation were pushed to as late as possible. This required a high degree of flexibility from the Program Committee chaired by *R. Vetschera* and the Organizing Committee chaired jointly by *N. Matsatsinis* and *J. Psarras*, but ultimately, a smooth organization of the conference and a comprehensive, high level scientific program could be achieved.

Holding an on-site part of the conference was possible because the local organizers had developed an excellent security concept with strict rules about admissions, masks and other hygiene measures. This created a very safe environment for those conference attendees who participated on site. The online part used a sophisticated platform developed by the local professional conference organizers.



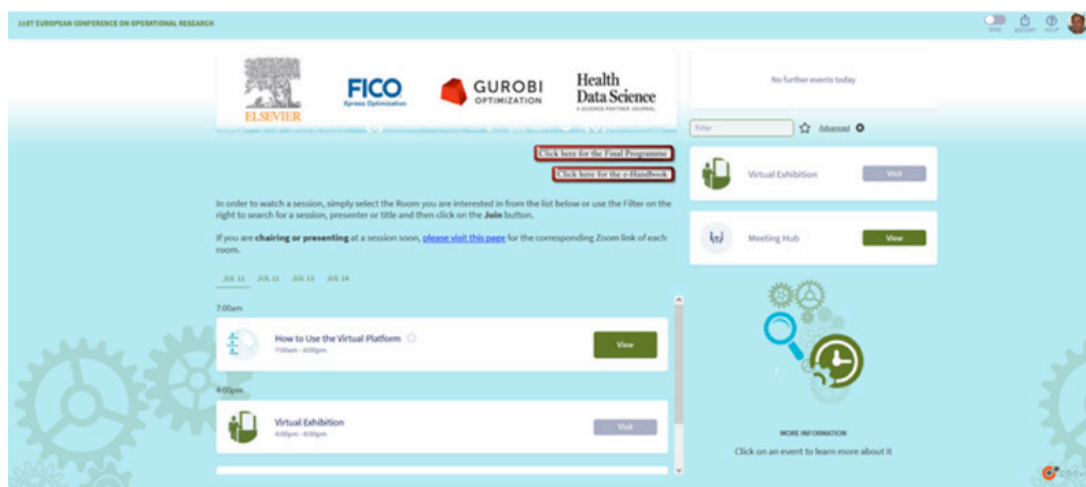
>> Presenters and speakers communicated via ZOOM, the audience could watch both online and on-site sessions via live stream and questions from the online audience could be asked via chat. This created a highly integrated environment for both the online and on-site presentations, so that all participants could take part in the entire range of sessions available at the conference. Although we all hope that in the near future, more on site conferences will again become possible, this conference serves as an excellent model how a hybrid conference could be organized in the future. Even if travel becomes easier again, a (small) online part might become a standard feature in future conferences to enable participation of those who cannot travel to the conference site.

The conference started on Sunday, July 11, with the opening session. As customary at EURO conferences, the opening session not only saw the welcome addresses of organizers and the host university, but also the *EURO Distinguished Service Award* and the *EURO Gold Medal*, the most prestigious OR award in Europe, were presented at the opening session. The EURO Distinguished Service Award was presented to *Ulrike Leopold-Wildburger*, Karl-Franzens University of Graz, Austria, who joined the session via ZOOM. The EURO Gold Medal was awarded to *Ailsa Land*, professor emeritus at London School of Economics and developer of the Branch and Bound Algorithm for integer programming. Sadly, she had passed away only two months before the conference, so instead of the customary presentation by the award winner about her work, several moving testimonials by her former students and collaborators about her achievements and her personality were presented.



▲ *EURO 2021*: Organization and Program Chairs at the Opening Session; from left to right: J. Psarras, N. Matsatsinis, R. Vetschera.

and Tuesday showed very well how OR is on the one hand adapting to and supporting the concepts and problems of big data and analytics made possible by the advances in computing technology, and on the other hand how OR is addressing important problems of our time. On Monday, *Coralia Cartis*, University of Oxford, presented her keynote on “*Optimization for Data Science*”, in which she discusses how recent advances in optimization methods support big data analysis. The *IFORS Distinguished Lecture* on Tuesday by *Janny Leung*, University of Macao, on “*Public Transportation for Smart Cities*” showed how important problems affecting the everyday lives of many can be solved using OR methods. The third plenary session was devoted to the interface between OR and high level decision making and featured two speakers who both bridge the gap between the academic world and high level political functions: *George Mavrotas*, National Technical University in Athens, who is now Secretary General of Sports in Greece, and *Yanis Varoufakis*, University of Athens, who served as finance minister of Greece during the economic crisis of 2015. Both presentations provided interesting insights into the role that analytical methods might play in high level decisions, and sparked a lively discussion in the on-site and online audience.



▲ *EURO 2021*: the conference platform.

The scientific program of the conference started with parallel sessions on Monday morning. Particular highlights of the scientific program were three plenaries and twelve parallel keynotes. The first two plenary lectures on Monday

In addition to these three plenary sessions, twelve keynotes covering the different scientific areas of the conference were given in parallel sessions. Three of these keynotes were given on site, the others online. The keynote presentations were: *Sirma Zeynep Alparslan-Gök*: “*Recent advances in Cooperative games and their potential on Economics and Operations Research situations under uncertainty*”, *Mirjana Kljajić Borštnar*: “*Enhancing organizational learning with AI*”, *Apostolos Burnetas*: “*Queues with Strategic Customers: Equilibrium, Social Welfare Optimization and Pricing*”,



Michael Carter: "How Can We Make a Real Difference in Healthcare? The Challenges of Implementation", Bissan Ghaddar: "Polynomial Optimization in Power and Water Network Operations", Juan Miguel Morales González: "Data-driven power systems", Judit Lienert: "Addressing Environmental Decision Problems with MCDA, Problem Structuring, and Behavioral OR", Ruth Misener: "Computational Mixed-Integer Nonlinear Optimization", Georg Pflug: "Financial Optimization: From data to models to solutions", Zilla Sinuany-Stern: "Foundations of OR: from LP to DEA", Leen Stougie: "Scheduling over scenarios", Katia Sycara: "The Science of the Deal: Teaming and Negotiating in Artificial and Human Societies".



▲ EURO 2021: Opening Session taking place under COVID restrictions.

In addition to the plenaries, keynotes, and regular parallel sessions, the program also contained several specific streams. The WISDOM (Women In Society Doing OR and MS) forum, which was created as a platform to support, empower and encourage the participation of all genders in Operational

R. Nohan and M. Tzur, "Reviews", C. Cleophas, C. Cottrill, J. Ehmke and K. Tierny, as well as "Theory and Methodology", L. Shen, S. Dauzère-Pérès, J. Neufeld, were announced. Furthermore, the EURO Doctoral Dissertation Award was presented to A. Florio (supervised by R. Hartl). Another highlight of the closing session was the outlook on EURO 2022, which will take place in Eespo, Finland, on July 3-6, 2022.



▲ EURO 2021: venue of the Conference Dinner.

In addition to the scientific program, on site attendants also had the opportunity to enjoy the social program, which included a *welcome reception* and a *farewell reception* at the conference site and a *conference dinner* at the Ble Pavillon in a spectacular seaside location at the coast of Alimos near Athens.

Overall, EURO 2021 can be considered as a very successful conference in difficult times, which showed the strength and resilience of the OR community in Europe and demonstrated the potential of a hybrid conference format to combine the strengths and possibilities of online and on site conferences. 🌐

Research within EURO, organized a round table on "Networking and career progression strategies" and a stream highlighting the achievements of young women in OR. The stream "Practice of OR (Making an Impact)" contained eleven sessions which on the one hand provided an exchange forum between academics and practitioners and on the other hand sessions explaining and introducing new concepts such as cloud computing and the Julia language to a wider audience. Furthermore, the conference also hosted the AI4RAILS Workshop on Artificial Intelligence for Railways as a satellite event.

In the closing session of the conference on Wednesday, July 14, the winners of the EJOR Best Paper Awards in the three categories "Innovative applications of OR",



▲ Cheerful at EURO 2021: from left to right: G.-W. Weber, E.M.T. Hendrix, B. Fortz, R. Vetschera, J. Jozefowska, S. Fores and N. Matsatsinis.



# 3rd IMA and OR Society Conference on Mathematics of OR – Celebrated in the UK and Online, in 2021.

## The Chair's Conference Review

Daniel Tilley <daniel.tilley@dtas.uk>

In November 2019, the *Institute of Mathematics and its Applications (IMA)* and the *Operational Research Society (ORS)* began organizing their 3rd joint conference on the *Maths of Operational Research* (<https://ima.org.uk/14347/14347/>), following successful conferences in 2017 and 2019. The event took place in April 2021 and was attended by over 122 academics and practitioners from over 16 countries. I was the chair (having served on the committee for the two previous conferences) and once again the conference was an amazing success.

This was the first *Maths of OR* conference that we conducted online, the technology we used worked very well. This included ZOOM for the talks and *Spatial* (<https://spatial.chat/>) for the more social sessions an excellent application which did allow for a modicum of social interactions including poster sessions, and sponsorship presence.

With many sessions running in parallel, I was not able to attend everything, highlights for me included:

On Day 1 the conference was opened by the ORS and the IMA Presidents respectively: *Professor Edmund Burke* (Deputy Vice Chancellor at the University of Leicester) and *Dr Nira Chamberlain* (Professional Head of Discipline-Data Science at SNC-Lavelin Atkins). They each talked about their professional societies and the collaboration between both in the past and the future that these types of events allow. This got the conference off to an excellent start.

The first plenary was given by *Dr Jakob Blaavand* from the Smith Institute on “*Creating impact with Maths and OR*”. *Jakob* gave a clear description of the various diverse projects of the Smith Institute for customers at Coca Cola, energy companies and many others.

I then attended the session ‘*Optimising Emergency Management*’. This session included speakers from Lancaster, Cardiff, and Dublin. This covered exciting topics such as using a simulation/optimization to design a resilient food supply network for natural disaster responses, modelling assisted evacuations, and other issues relating to deployment of emergency services.

For the *Poster sessions*, the following three really stood out to me included:

- Two defence related posters:
- o Evaluation of sources of intelligence using a multi-armed

## 2. How to Find an Optimal Hiding Strategy

- **Finite  $p$  game:** Searcher limited to Gittins search sequences against  $p$  splitting all index ties by a permutation ( $n!$  in total)
- E.g.  $\sigma = (2, 3, 1)$  - tie between indices of boxes 1 and 2 split '2' then '1'

### Proposition

$p$  optimal in search game  $\iff p$  optimal in finite  $p$  game

- Often optimal:  $p^0$  with

$$\frac{p_1^0 q_1}{t_1} = \dots = \frac{p_n^0 q_n}{t_n}.$$

▲ 3rd Mathematics of OR Conference: Plenary by Kevin Glazebrook and Jake Clarkson: “Index Policies and Search Games”.

bandit framework; from Lancaster University  
o Routing and trajectory optimisation of unmanned aerial vehicles; from the University of Southampton  
• Multi-site, and multi-service modelling for elderly and frail patients; From Cardiff University. This work developed a stochastic model to determine demands for hospital beds for frail patients.

Day 2 started with a plenary from Kevin Glazebrook and Jake Clarkson (Lancaster University) “Index Policies and Search Games”. This provided key influential ideas along with some very recent work on solutions to a class of multi-armed bandit problems search games. This really got into the Maths of the subject area and the application areas such as patrolling, target tracking and ship resupply, once again this type of talk really appealed to me as these problems are key in defence (among other areas).

One of the parallel sessions I attended on Day 2 was ‘*Applications and Development of Simulation in Operational Research*’. A repeated theme in this session was the need to reduce input uncertainty and bias in simulation runs. This session included talks from Warwick, Southampton, and Lancaster Universities.

Day 3 started with a plenary from *Christina Pagel* (Clinical OR Unit) called “*The Intersection of Operational Research and Public Communication during the COVID-19 Pandemic*”. In this fascinating plenary, *Christina* reflected on her experience as a member of SAGE (the UK Government Scientific Advisory Group for Emergencies). *Christina* talked about what the analysts got right and where they went wrong, particularly in terms of how results can be wrongly presented and/or wrongly interpreted.

The last day of the conference included two plenaries as well as parallel sessions. The first plenary was by *Dolores Romero Morales* (Copenhagen Business School), and was entitled “*Data-Driven Decision-Making Needs More Transparency. Optimization Can Help*”. >>

## Enhancing transparency

## Enhancing transparency

## • Sparseness:

Atamtürk and Gomez [2019], Benítez-Peña et al. [2019, 2020, 2021], Bertsimas et al. [2016], Blanquero et al. [2021b], Carrizosa et al. [2020a], Fountoulakis and Gondzio [2016], Maldonado et al. [2014], Rinaldi et al. [2010], Rinaldi and Sciandrone [2010]

## • Finding prototypes:

Carrizosa et al. [2007, 2021d], Hart [1968], Wilfong [1992]

## • Enhancing interpretability of black-box methods such as SVM, RF and DL:

Bénard et al. [2019], Carrizosa et al. [2010, 2011, 2016, 2017, 2020a, 2021c,b], Carrizosa and Romero Morales [2013], Chevalerey et al. [2013], Golea and Marchand [1993], Li et al. [2017], Ustun and Rudin [2016]

## • Building easy-to-understand structures such as rules and trees:

Baesens et al. [2003], Blanquero et al. [2021a, 2020a,b], Bertsimas and Dunn [2017], Dash et al. [2018], Martens and Provost [2014], Orsenigo and Vercellis [2003, 2004]

Dolores Romero Morales

8/51

▲ 3rd Mathematics of OR Conference: Plenary by Dolores Romero Morales: "Data-Driven Decision-Making Needs More Transparency. Optimization Can Help".

>> This talk showed how optimization techniques can be used to improve the transparency in Data Science models. I then attended the 'Multilevel Energy Transmission' session covering optimization of storage and transmission of energy.

The last session I attended was 'OR Applications I', which contained two talks on diverse subjects. The first looked at using game-theoretic models (based on the work of John Nash and Lloyd Shapley) to help banks share the cost of the UK ATM network (a key part of UK financial infrastructure). The other talk was defence related, dealing with the determination of optimal salvo sizes.

The final plenary was by Nick Harris (Dstl), entitled "An Analyst in Lockdown". This was an excellent talk to end the conference on and had high attendance. The talk explored the implications (pluses and minuses) of working from home, due to COVID, for a Government agency such as Dstl (but also more generally). It was a timely talk for all Operational Analysts

Optimisation turned out to be a key theme at the conference. There were also sessions on continuous, discrete, stochastic, and dynamic optimization, and talks highlighting important applications, in healthcare, and transportation. There were also talks on the interface between OR and Machine Learning, Data Science and Business Analytics. There were a number of things that happened during the organization of the conference that meant that what was delivered was not the conference I personally wanted to deliver:

I thought that the conference would once again be held in Birmingham at a conference centre. However, when COVID

occurred we had to take the conference. Online. Thus, the interactions and networking that an in-person conference allows, was not possible (however Spatial did help).

COVID also meant that a number of sessions that we hoped to get organisers for did not occur leading to application areas such as Defence and Cyber Security being not being represented as the committee would have liked. There was also an unfortunate gender imbalance at the conference. In part, this was because the committee became pre-occupied by how we could take the conference online, but also many who turned

us down stated they had concerns about COVID particularly childcare issues. This issue was partially addressed by holding a meeting of the Women in OR and Analytics Network (WORAN) during the conference, to discuss the roots of the issue and how future committees might address them.

I put forward the idea for the Mathematics of Operational Research Conference in 2015, to enable mathematical approaches to OR to be showcased and celebrated. I recommended that the conference be run as a joint event by both the IMA and the ORS and have been involved in all three. This may not have been the conference I wanted to deliver, however it was an excellent conference and everyone involved in the organising committee, the ORS and IMA who helped develop the conference, and the conference sponsors The Alan Turing Institute and the Smiths Institute should be happy with the result.

**Dr Daniel Tilley** is a leading technical expert with 20 years' analytical experience in the defence and security sector, he is a qualified Project Manager, Team Leader and Model/Simulation tester and has two undergraduates first class degrees with honours. Daniel currently runs his own analytical consultancy in defence and cyber security. 🌐

## Operational Research in Dstl (1)

[dstl] The Science Inside

- Defence, within government, has a long history in delivering Operational Research (OR)
- Dstl has become a hub for a significant proportion of this capability
- As an organisation it is concerned about its professional development
  - Retaining close links with ORS and GORS
- In addition to OR there is a lot of other analysis and science requiring maths
  - my professional experiences are largely informed by the delivery or assurance of OR



Source: Imperial War Museum

© Crown copyright 2021 Dstl

▲ 3rd Mathematics of OR Conference: Plenary by Nick Harris: "An Analyst in Lockdown".



# Semi-infinite Optimization meets Industrial Application in Kaiserslautern, Germany and Online - ASIP 2021:

## A Pioneering Event

**Jan Schwientek** <Jan.Schwientek@itwm.fraunhofer.de>

**Karl-Heinz Küfer** <Karl-Heinz.Kuefer@itwm.fraunhofer.de>

**Oliver Stein** <Oliver.Stein@kit.edu>

*Semi-infinite optimization*, i.e., the solution of optimization problems with infinitely many constraints (*SIP*), has been intensively studied over the last decades. The progress of computer technology has enhanced *SIP* methodology significantly. On the one hand, solution methods for this problem class have been increasingly developed and refined. On the other hand, high-dimensional problems, as they often occur in practice, have become numerically tractable. As a result, the range of possible applications has evolved considerably and semi-infinite optimization has been increasingly applied to practical problems in recent years.

In addition to the standard applications of semi-infinite optimization such as model approximation, design centering, robust optimization, and optimal control, *SIP* techniques have been recently used in machine learning, design of experiments, coverage issues and mixed stochastic-robust optimization. Thereby, *SIP* methods have been applied in application areas such as product portfolio optimization and process engineering.

For these reasons, the *Division Optimization of Fraunhofer ITWM*<sup>[1]</sup>, Kaiserslautern, Germany, and the *Chair of Continuous Optimization at IOR - KIT*<sup>[2]</sup>, Karlsruhe, Germany, organized an online workshop<sup>[3]</sup> on May 20-21, 2021, in order to take these developments into account and to intensify the exchange between scientists and application experts. This was already the 6th workshop on semi-infinite optimization, but the first one entirely dedicated to applications.

71 participants from 18 countries from 4 continents had registered for the 2-day workshop. The presentation program consisted of 5 plenary talks, 12 contributed and 3 short talks divided into 7 sessions

In the session on “*SIP and machine learning (ML)*”, Prof. Dr. Süreyya Akyüz (Bahçeşehir University Istanbul, Turkey) showed in her plenary lecture very clearly the many connections between semi-infinite optimization and ML, which were supported by two Fraunhofer ITWM staff members (Dr. Jochen Schmid and Philipp Seufert) in their talks on shaped-constrained regression and ML-based optimal design of experiments applied in mechanical and process engineering.

The first session on “*SIP and optimization under uncertainty*” focused on *multi-objective problems*. Prof. Dr. Ralf Werner (University of Augsburg, Germany) generalized in his plenary talk the regret approach (minimize some deviation of possible decisions under uncertainty against the optimal decision) from the single-objective to the multi-objective case and showed how the resulting problem can be solved as a *SIP*. Dr. Ernest Quintana (TU Ilmenau, Germany) talked on a set-based approach to solve uncertain MCO problems with *SIP* techniques, while Holger Berthold (Fraunhofer ITWM, Germany) addressed an inverse approach (increasing the uncertainty set without significantly degrading the solution quality).



▲ Sparkling banner of ASIP 2021.

The first session on “*SIP and optimal control*” focused on *technical applications*. After a very clear overview of discretization methods for *SIP*, Prof. Dr. Alexander Mitsos (RWTH Aachen, Germany) showed in his plenary lecture *SIP* applications in process engineering and contigenting power grids. Dr. Adrian Caspari (also RWTH Aachen, Germany) dedicated his presentation to the use of *SIP* for the generation of optimal disturbance models for offset-free nonlinear model-predictive control, while Dr. Helene Krieg (Fraunhofer ITWM, Germany) demonstrated the use of *SIP* to determine optimal product portfolios for a pump manufacturer.

In the first session on “*numerical methods for SIP*”, the workshop co-organizer Prof. Dr. Oliver Stein (KIT, Germany) and the current *EUROPT Chair* Prof. Dr. Giancarlo Bigi (University of Pisa, Italy) pointed out the connection between *SIP* and Nash problems (in game theory) by showing how equilibrium selection leads to *SIP* formulations, and how Nash game solution methods can be applied to solve *SIPs*, respectively. Dr. Pradeep Kumar Sharma (University of Delhi, India) concluded the session with his talk on the connection between *SIP* and set-valued optimization.

In another session on “*SIP and optimal control (under uncertainties)*”, Prof. Dr. Gerhard-Wilhelm Weber (Poznan University of Technology, Poland) gave a plenary talk on stochastic optimal control problems, which, due to time dependence, re-present a *SIP* parameterized by the random variables. This was followed by two talks by Prof. Dr. Martin Gugat and Prof. Dr. Michael Stingl (both FAU Erlangen-Nuremberg, Germany) on optimal control with dynamic probabilistic constraints and bundle methods for nonlinear robust optimization.



▲ ASIP 2021: some of the workshop speakers.

The second session on “*SIP and optimization under uncertainties*” focused on connections between *stochastic optimization and SIP*. First, PD Dr. René Henrion (WIAS Berlin, Germany) gave an overview of ordinary probabilistic constraints in his plenary lecture, before he connected them to semi-infinite optimization by means of probabilistic-robust, or, for short, probust constraints (constraints that include random variables and a worst-case consideration of other variables). Dr. Holger Heitsch (also WIAS) presented a numerical method for solving such probust problems and applied it to the optimization of water reservoirs. Prof. Dr. em. Werner Römisches (HU Berlin, Germany) concluded the session with a presentation on optimal scenario generation for two-stage stochastic problems using semi-infinite optimization.

In the second session on “*numerical methods for SIP*”, two staff members of the Fraunhofer ITWM (Dr. Jan Schwientek and Dr. Tobias Seidel) reported on adaptive discretization methods

for general semi-infinite optimization and with quadratic convergence and showed their performance in the volume-optimal utilization of colored gemstones.

In addition to a short discussion round after each presentation, there was the opportunity to exchange ideas in pairs or in groups during the workshop breaks using the socializing tool wonder.me. Despite the virtuality of the event, a social event was not to be missed. This took place in the form of a virtual wine tasting with a Palatinat winery, for which the speakers had been sent a wine/

juice tasting package in advance.

The workshop was finally also taken as an occasion to announce a special issue on applications of semi-infinite optimization<sup>[4]</sup> in *Mathematical Methods of Operations Research (MMOR)*. Submission of papers is open to everyone, not only the workshop participants, and is possible until September 30, 2021.

## References

- [1] <https://www.itwm.fraunhofer.de/en/departments/opt.html>
- [2] <https://kop.ior.kit.edu/english/index.php>
- [3] [https://www.leistungszentrum-simulation-software.de/en/news-events/Fairs\\_conferences\\_and\\_events/2021/2021\\_05\\_ASIP.html](https://www.leistungszentrum-simulation-software.de/en/news-events/Fairs_conferences_and_events/2021/2021_05_ASIP.html)
- [4] <https://www.springer.com/journal/186/updates/19112764> 🌐

# ECCO XXXIV - The European Combinatorialists Meet Online in Madrid

**Silvano Martello** <silvano.martello@unibo.it>

Almost 130 participants from Albania, Algeria, Austria, Belgium, Brazil, Canada, China, France, Germany, Greece, Hungary, India, Ireland, Israel, Italy, Mexico, Norway, Philippines, Poland, Portugal, Slovenia, Spain, Sweden, Tunisia, Turkey, United Kingdom, United States, and Vietnam got together for ECCO XXXIV from June 10 to June 11, 2021 (<https://ecco2021madrid.com/en/>). The conference, originally planned to be held in Madrid, hosted by the *Real Academia de Ciencias* and the *Universidad Rey Juan Carlos*, was held online due to the COVID-19 emergency.

This was the annual conference of the *European Chapter on Combinatorial Optimization (ECCO)*. The scientific program included about 65 talks on several aspects of combinatorial optimization, covering its main theoretical and application aspects. Thanks to the financial support of *EURO*, the registration fees were waived to 20 PhD students and young researchers.

Three plenary lectures were delivered by

- Laureano Escudero, Universidad Rey Juan Carlos (Madrid), on “*Dynamic Multiple Allocation Capacitated Hub Location Expansion Planning under Uncertainty*”;
- Martine Labbé, Université Libre de Bruxelles, on “*Linear Bilevel Optimization*”;
- Mihalis Yannakakis, Columbia University (New York), on “*Approximation of Multiobjective Optimization Problems*”.

The Program Committee was chaired by Laureano Escudero and Silvano Martello, the Organizing Committee by Antonio Alonso-Ayuso and Laureano Escudero.

The EURO Working Group on Combinatorial Optimization, ECCO (<http://ecco.grenoble-inp.fr>) was created in 1987 by C. Roucairol, A. Rinnooy Kan, and D. de Werra. For the first ten years it was chaired by Catherine Roucairol. Since 1987 it is chaired by Silvano Martello. ECCO has since then gathered researchers working in different fields of operations management, logistics, >>





▲ ECCO XXXIV: Online Plenary Lecture of Mihalis Yannakakis (top left corner). Among the participants, Yves Crama, Alain Hertz, Laureano Escudero, Martine Labbé, Silvano Martello, Ulrich Pferschy and Paolo Toth.

>> production scheduling, location and distribution problems, resource allocation, flexible manufacturing, metaheuristics, to name a few. Since 1988, the group has been bringing researchers together each year to discuss the latest advances in combinatorial optimization, with only two exceptions: *ECCO IV*, Dubrovnik 1991 (canceled due to war situation) and *ECCO XXXIII*, Saint Petersburg (canceled due to COVID-19 lockdown). With over 1600 members, *ECCO* it is currently one of the largest working groups of *EURO*.

Every fourth year the conference is held as a joint meeting with *CO*, a series of combinatorial optimization conferences that started in the UK in 1977, currently coordinated by *Bo Chen*.

A special issue of the journal *Discrete Applied Mathematics* on “CO emerging applications, models and algorithms” (open to

all *ECCO* and *CO* members) was launched, with submission deadline of November 30, 2021.

*ECCO* has a tradition of conferences held in charming locations: The latest conferences (2000-) were held in Capri, Bonn, Lugano, Molde, Beirut, Minsk, Porto, Limassol, Dubrovnik, Jerusalem, Malaga, Amsterdam, Antalya, Paris, Munich, Catania, Budapest, Koper, Fribourg, and Malta.

The next meeting, *ECCO XXXV - CO 2022 Joint Conference*, organized by *Alexander Kulikov*, will take place, hopefully on site, in Saint Petersburg (Russia), from June 9 to June 11, 2022, hosted by the Steklov Mathematical Institute of the Russian Academy of Sciences, see <https://ecco2022.euro-online.org/>. Saint Petersburg, Russia's cultural capital, is home to the *Hermitage*, one of the largest art museums in the world. Its historic centre is a *UNESCO* World Heritage site. 🌐

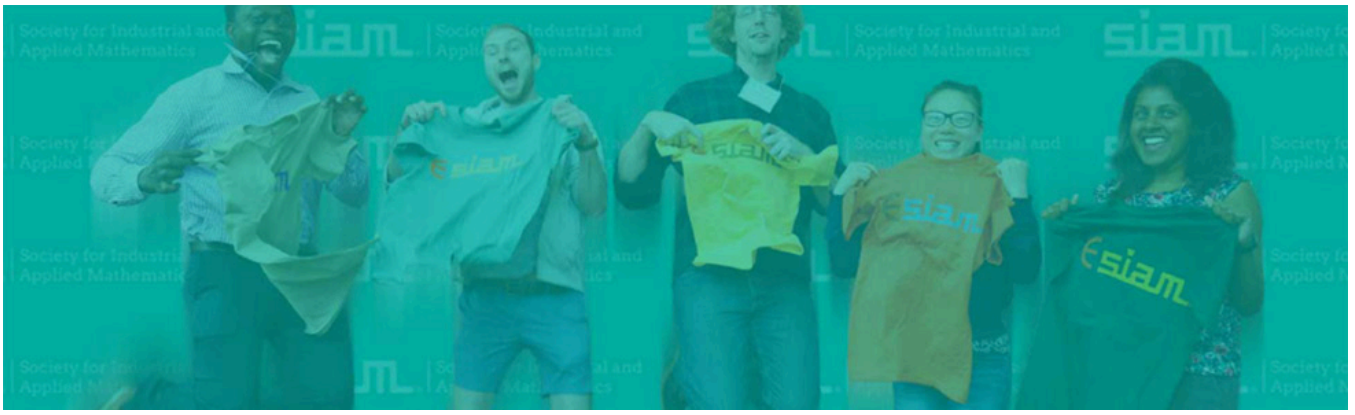
## Finance and OR Happening Virtually and Worldwide - With SIAM in Philadelphia, USA

**Kerem Ugurlu** <kerem.ugurlu@nu.edu.kz>

The *SIAM Conference on Financial Mathematics and Engineering (FM21)* had been surprisingly amazing in a way how every single talk is connected to our *operational research* and reflects the soul of *operational research* application fields. Actually, the conference which was held on June 1-4, 2021, was planned to take place in the beautiful city of Philadelphia in the USA but because of the current situation it was organized in *online* format. Even though it was unfortunate for an on-site event to be cancelled, the conference in online format surprisingly exceeded expectations. In fact, it has been even more efficient in terms of logistics during the event since the attendees could easily switch between chat rooms anytime and listen to all the speakers we wanted to hear from. Moreover, it is more convenient to record the presentations through *ZOOM*

platform so that we can watch and listen there any time we want in the future through the virtual conference platform.

The conference based on mathematical finance and its subbranches which is a core application of *OR* and acted as a nice platform for sharing knowledge and ideas in the areas of fundamental research and implementation of practices in financial engineering, computation, and operations. It was great honor to share our knowledge among *operational research* enthusiasts, applied mathematicians, applied probabilists, statisticians, computer and data scientists, economists as well as industry practitioners from all over the world, and been given the opportunity to present our work and get some feedback from different perspectives.



▲ FM21: SIAM Conference on Financial Mathematics and Engineering (Retrieved from the official website).

Moreover, I believe that the conference was very appealing and beneficial for all attendees since all the sessions of the conference were linked to OR and its application to real-world problems. In fact, the sessions on mean field games and applications, model uncertainty in financial engineering, robust control in finance, machine learning applications in financial mathematics, are at the heart of OR. There were *mini-tutorials* conducted which are also very important for OR, namely *"Machine Learning by finance"*, by *Maxime Bergeron* from Riskfuel Inc., Canada, and *Prof. Sebastian Jaimungal* from University of Toronto, Canada, which focused on methods for solving discrete time stochastic control problems that arise in finance, and *"Trading with Friction"* by *Prof. Halil Mete Soner* from Princeton University, USA, and *Prof. Paolo Guasoni* from Dublin City University, Ireland. It was a great honor to participate in the invited talk *"When Does Portfolio Compression Reduce Systemic Risk?"* by *Prof. Luitgard Veraart* from London School of Economics and Political Science, UK.

Furthermore, I was very satisfied with how the event proceeded and the presentations *"Iterative Methods for Solving Stochastic Optimal Control Problems"* by *Prof. Bekzhan Kerimkulov*, from University of Edinburgh, UK: *"Stochastic Gradient Flows for Unsupervised Learning: An Alternative to Gans"* by *Prof. Yu-Jui Huang* from University of Colorado Boulder, USA: *"Modelling Covid-19 Contagion: Risk Assessment and Targeted Mitigation Policies"* by *Prof. Rama Cont*, *Prof. Artur Kotlicki* and *Prof. Renyuan Xu* from University of Oxford, UK: *"A Macroeconomic SIR Model for Covid-19"* by *Prof. April Nellis*, *Prof. Erhan Bayraktar* and *Prof. Asaf Cohen* from University of Michigan, USA, were very interesting for me. There were a lot of other interesting presentations and talks, which offered a variety of perspectives and applications of OR.

There have been special award events, namely *"SIAM Activity Group on Financial Mathematics and Engineering Early Career Prize"* to individuals in their early careers for distinguished contributions to mathematical modeling in finance, and *"SIAM Activity Group on Financial Mathematics and Engineering Conference Paper Prize"* for outstanding research presented by students or postdocs at this conference.

Robust optimization is a methodology which can deal with the uncertainty or variability in optimization problems by computing a solution which is feasible for all possible scenarios of the data

within a given uncertainty set. OR and robust optimization are necessarily related to each other. So that, in this conference, it is honor to present my paper in one of the very important areas of OR that is robust control in finance. I presented my paper *"Robust Utility Maximization of Terminal Wealth with Drift and Volatility Uncertainty"* which gives explicit solutions for utility maximization of terminal wealth problem in the presence of Knightian uncertainty within a continuous time interval  $[0, T]$  and solves the robust optimization problem with logarithmic, power and exponential utility functions, explicitly. The conference was an excellent opportunity to share ideas for further (notably operational) research and meet experts from all over the world.

I would like to thank the Organizing Committee of this conference and the chair of my session *"Robust Finance"*, *Prof. Francesca Biagini* from Ludwig-Maximilian University of Munich, Germany. I especially would also like to thank *Prof. Gerhard-Wilhelm Weber* introducing me to this conference and giving me the opportunity to share my knowledge in the conference.

All the presentations and talks were based on main applications of OR, and the conference itself as a whole was close to the heart of OR so that it has been very valuable and beneficial for all of us. Thus, in the future we may to contribute to this kind of events with OR, organize further conferences to share our ideas and knowledges, and we have to support and "finance" OR since it takes a very important role in our lives.

**Kerem Ugurlu** (Ph.D. 2016, University of Southern California), is working as an Assistant Professor of mathematics at Nazarbayev University, Kazakhstan. His research areas are stochastic control theory and its applications in scenarios motivated by finance. 🌍



▲ FM21: The beautiful scenery of Philadelphia (Retrieved from the official website).



# OR Road-to-Future Forum in 2021: An Online Forum Held by Operations Research Society of China - Since 2020

Yu-Hong Dai <dyh@lsec.cc.ac.cn> Deren Han <handr@buaa.edu.cn>

## Introduction

COVID-19 has clearly brought much inconvenience to every aspect of living so to enhance academic interchange in such an abnormal environment, the *Operations Research Society of China (ORSC)* recently organized an *OR Road-to-Future Forum*. This is a series of online fora, which started on April 30, 2020, and has continued once a week during 2020 and once every two weeks in 2021.

## Types and topics of talks held

To date, there have been 64 talks given in English or Chinese from outstanding global operational researchers, including *IFORS* President Professor M. Grazia Speranza from the University of Brescia (Italy), Professor Yinyu Ye from Stanford University (USA), Professor Zhiquan Luo from The Chinese University of Hong Kong (Shenzhen, China), and Professor Defeng Sun from The Hong Kong Polytechnic University (Hongkong, China).

The *OR Road-to-Future Forum* focuses on mathematical programming, graph theory, computational mathematics, bioinformatics, machine learning, artificial intelligence, engineering problems and their applications, providing a good opportunity for the global research community to discuss recent research results and develop new ideas and collaborations in a friendly and relaxed atmosphere. Interested people can also watch the playback through *Bilibili* if they missed the live broadcast, enjoy the elegant demeanor of academic celebrities, and acquire important knowledge anytime and anywhere. Based on the talks, the *Journal of the Operations Research Society of China* will release a special issue in English by the end of 2021.

## Feedback from attendees

Young researchers and graduates are the main audiences and



▲ *OR Road-to-Future Forum*: "mosaic" screenshot on community online.

more than 10,000 people have attended the meetings so far. Some of these young scholars have expressed their opinions, for example:

- Wei Bian from Harbin Institute of Technology: "It has become a habit and an enjoyment to participate this activity every week for many scholars and students. In all reports, the speakers not only imparted the core achievements of their research by simple ways, but also gave some constructive and instructive suggestions for further research. *OR Road-to-Future Forum* not only helped us understand the significant and latest research at home and abroad, but also inspired and encouraged us to move forward by its regular series of activities."

- Cong Sun from Beijing University of Posts and Telecommunications: "This forum is not only a platform for scholars to exchange the recent academic developments in operations research, but also a bridge connecting our OR area and others."

- Caihua Chen from Nanjing University: "What impressed me most is that this forum invited lots of scientists and engineers to share many practical problems and show how OR can help. This will definitely inspire OR practical research in China and encourage young students into this interesting and practical OR areas."

To **join future meetings** in this year of 2021 please see:  
<https://meeting.tencent.com/p/4642329042>, ID: 464 232 9042, PIN: 234567.

Cordial thanks to VP International Activities at *INFORMS*, Mrs. Sue Merchant, for kindly communicating this report. 🌐

## Contents

**Operations Research: An interdisciplinary-science-based and data-driven strategy/policy/decision making process/system under complex/uncertain/dynamic environments.**

- Reopen Economy – Algorithm-Based Production Planning/Dispatching in a Pandemic
- Inventory and Risk Pooling of Medical Equipment and Supply-Chain-Network Management
- Monte Carlo/Computer Simulation Methods for Drastic and Rare Scenario Analyses
- New Norm: Operation/Optimization under Social Distance Constraints
- Indoor GPS and Tracking by Sensor Network Localization for Contact-Tracing
- Dynamic and Equitable Region Partitioning for Hospital/Health-Care Services
- Efficient Public Goods Allocation under Tight Capacity Restriction via Market Equilibrium Mechanisms/Platforms
- Identifications and Protective Measures for High-Risk Groups in a Pandemic
- Machine-Learning (e.g., Logistic Regression) of Multiple Social Features to Reduce Pandemic Fatality

▲ *OR Road-to-Future Forum*: a screenshot of one of the talks.

# MCDA Methods Selection Software (MCDA-MSS 2021): A Radar for Decision Analysts

**Marco Cinelli** <marco.cinelli@put.poznan.pl> **Miłosz Kadziński** <milosz.kadzinski@cs.put.poznan.pl>  
**Roman Słowiński** <roman.slowinski@cs.put.poznan.pl>

The *workshop on the Multiple Criteria Decision Analysis Methods Selection Software (MCDA-MSS)* was held virtually on June 1, 2021, under the auspices of the INFORMS MCDM section. It was organized and presented by *Marco Cinelli*, a Marie Skłodowska-Curie Global Fellow at the Institute of Computing Science of Poznan University of Technology (Poland), the Laboratory for Energy Systems Analysis of the Paul Scherrer Institute (Switzerland), and the Center for Environmental Solutions and Emergency Response of the U.S. Environmental Protection Agency in Cincinnati (USA).

The organizing committee of the event also included *Miłosz Kadziński*, Associate Professor at the Institute of Computing Science of Poznan University of Technology and a Polish Young Academy member, and *Roman Słowiński*, Professor and Founding Chair of the Laboratory of Intelligent Decision Support Systems at Poznan University of Technology, and a Professor in the Systems Research Institute of the Polish Academy of Sciences.

The *MCDA-MSS* is nowadays the most comprehensive software for recommending MCDA methods. This software contributes to the meta-decision-making problem caused by the very large number of MCDA methods available at this time, being the decision of which MCDA method(s) to use for a certain decision-making problem. This challenge is summarized in the figure below, and the *MCDA-MSS* provides systematic guidance of an analyst facing it.

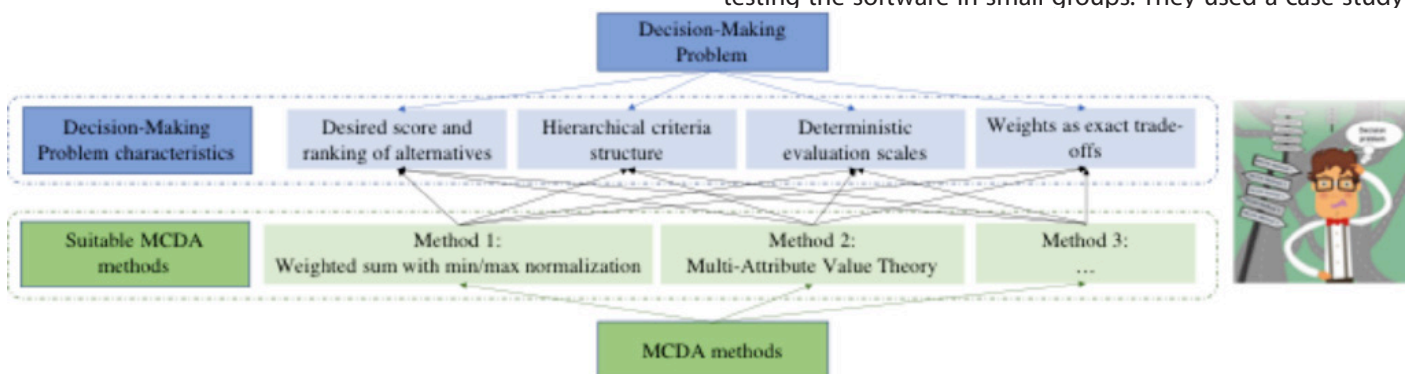
the first one attended by all the attendees ( $N = 60$ ), and the remaining ones attended by a subset ( $N = 27$ ). The attendees came from many countries, including Brazil, Canada, Croatia, France, India, Italy, Poland, Republic of Serbia, Switzerland, Turkey, the UK, and the USA.

The first session focused on the presentation of the methodological background of the *MCDA-MSS* with its four sections:

1. *Problem typology*: Defines the type and structure of the decision-making problem;
2. *Preference model*: Defines the type of model that the user would like to apply;
3. *Elicitation of preferences*: Defines the type, modality and frequency of model preferences;
4. *Exploitation of the preference model*: Defines the strategy used to derive and enrich the decision recommendation.

The second session was dedicated to the analysis of the background material that 10 attendees submitted before the event. This allowed for a discussion on the features recommended by these attendees and considered fundamental in driving the selection of MCDA methods and those included in the *MCDA-MSS*.

In the third session, the attendees had the opportunity of testing the software in small groups. They used a case study



"Which is the most suitable MCDA method (or subset of methods) that should be used for a given decision-making problem?"

The *MCDA-MSS* includes 205 MCDA methods, each one assessed with 156 objective features. The latter make the complexities of decision-making more transparent and manageable, as well as provide an extensive basis for a long-lasting and traceable development of MCDA methods.

The workshop on the *MCDA-MSS* included four main sessions,

(Gasser et al. 2020) that was briefly presented by the convener (*Dr. Cinelli*) and answered the questions of the *MCDA-MSS* to reach a recommendation of relevant methods. This was the longest and most interactive session of the workshop, where the attendees had the opportunity to use the software and clarify any doubts they had about it.

The MCDA-MSS team		
Dr. Marco Cinelli*, Assoc. Prof. Miłosz Kadziński, Grzegorz Miebs, Prof. Roman Słowiński	Dr. Michael Gonzalez	<b>Dr. Peter Burgherr</b>
*: marco.cinelli@put.poznan.pl / Poznan University of Technology (PL)	<b>U.S. EPA (USA)</b>	<b>Paul Scherrer Institute (CH)</b>



## 2. The research contributions

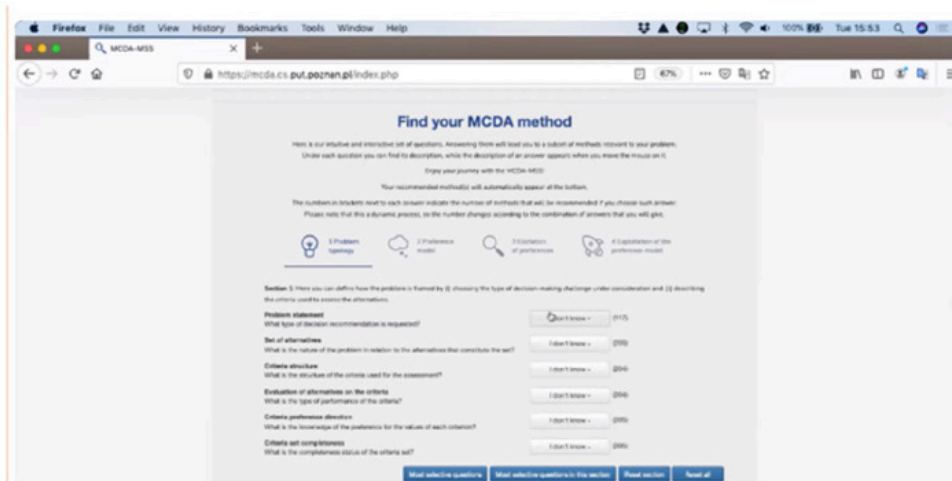
- Develop **MCDA-Methods Selection Software (MCDA-MSS)** to recommend the most relevant MCDA method(s) for each decision-making problem. MCDA-MSS:
  - Allows analysts to learn our sequential and dynamic framework to describe complex decision-making
  - Elaborates the most comprehensive existing database of over 200 MCDA methods
  - Provides solutions to the case studies where no method that matches all the requirements from the analyst is recommended
  - Offers a strategy to reduce a large set of methods when there is a lot of uncertainty in the description of the DMP
  - Can be used as an identifier of errors in MCDA method selection & provide more suitable methods

▲ MCDA-MSS: research contributions.

### How can MCDA-MSS help you with your decision-making problem?



▲ A snapshot of the features proposed by the attendees (in green) with respect to those included in the MCDA-MSS.



▲ MCDA-MSS web-platform: an introduction.

The last session was dedicated to a brief summary of the event and planning of deliverables, which include a repository of decision-making problems that have been tackled by the attendees and a scientific paper summarizing the key learning insights from the event.

MCDA-MSS is available free of charge at the following link: <http://mcdamss.com>.

The MCDA-MSS team is eager to engage in a community-wide initiative involving experts in MCDA methods, decision analysts using these methods, and decision makers receiving decision recommendations. This combined action can result in an expansion of the methods repository as well as the tests on case studies, coupled with the inclusion of additional

decision aiding features in the web software. The outcome of this initiative can be a sustained contribution to the relevant and transparent use of MCDA methods to solve real-world problems. All these activities can be monitored on the MCDA-MSS dedicated webpage <http://mcdamss.com>.

This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 743553.

## Reference

Gasser, P., J. Suter, M. Cinelli, M. Spada, P. Burgherr, S. Hirschberg, M. Kadziński, and B. Stojadinović. 2020. Comprehensive resilience assessment of electricity supply security for 140 countries. *Ecological Indicators*, 110:105731.

# Production and Operations Management Society's 31st Annual Conference - Building a Sustainable, Responsible and Resilient Global Future

**Jerry Burke** <gburke@georgiasouthern.edu>

*Production and Operations Management Society (POMS)* is an international professional organization representing the interests of *POM* professionals from around the world. The purposes of the Society are:

- to extend and integrate knowledge that contributes to the improved understanding and practice of *production and operations management (POM)*;
- to disseminate information on *POM* to managers, scientists, educators, students, public and private organizations, national and local governments, and the general public; and
- to promote the improvement of *POM* and its teaching in public and private manufacturing and service organizations throughout the world

The *POMS 31st Annual Conference* (<https://pomsmeetings.org/conf-2021/>) was held online from April 30 - May 5, 2021. The annual conference planned for Minneapolis in 2020 was cancelled due to COVID-19, but the organizing committee adapted and pivoted the 2020 theme for the 2021 online venue. The conference attendance was about 1,500 people and consisted of many special events and 33 tracks spanning a wide range of topical themes. It is the collective efforts of all presenters, track chairs, session chairs and track technical managers for online support that executed a smooth and enjoyable conference.

From the *POMS 2021 Program Book* (<https://pomsmeetings.org/conf-2021/documents/POMS-2021-Program-Book.pdf>):

"Scott Webster (general chair), Burak Kazaz, Hongmin Li and Rachna Shah (program co-chairs) worked with many track chairs to populate this year's tracks. Burcu Keskin and Gil Souza serve as co-chairs for the Emerging Scholars program. Karen Donohue and Susan Goldstein co-chair the Doctoral Consortium program. Subodha Kumar and Rakesh Mallipeddi provided expertise with technological requirements for hosting virtual sessions which comprise this year's conference.

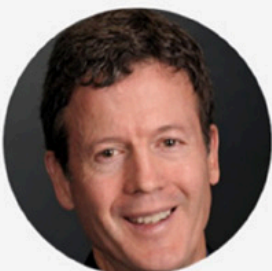
## PRODUCTION AND OPERATIONS MANAGEMENT SOCIETY



▲ Conference banner of POMS 2021.

Ken Klassen's hard-work and attention to detail as scheduling chair helped provide order to the conference. Hossein Rikhtehgar Berenji was also instrumental in scheduling activities for the conference. Tej Dhakar humbly served as editor of the proceedings. Bala Shetty and Rakesh Mallipeddi helped direct sponsorship and programming focused on education. Bharat Kaku, as V.P. of Finance, kept our financial books in order. V.P. of Colleges, Xiuli He, coordinated the many and varied efforts of POMS Colleges to emphasize interest groups of our society. Nagesh Murthy continues to represent POMS in leading our global initiatives. Of course, this event like so many other POMS activities, depends on executive leadership from Sushil Gupta, and coordination expertise from Seema Singhanian and Ram Tewari."

The conference opened on Friday, April 30, 2021, with several special events including a doctoral consortium and four mini-conferences of *POMS Colleges* which represent special interest groups within *POMS*: Healthcare Operations Management; Humanitarian Operations and Crisis Management; Operational Excellence; and Product Innovation and Technology Management. Several other *POMS colleges* sponsored best paper competitions presented throughout sessions in the main conference. A special session for Emerging Scholars Program for junior faculty happened on May 3, 2021. Additionally, there were dedicated events to engage attendees such as the e-debate session, and sessions to meet *POM* journal editors.



**Dr. Scott Webster**  
General Chair



**Dr. Hongmin Li**  
Program Co-Chair



**Rachna Shah**  
Program Co-Chair



**Dr. Burak Kazaz**  
Program Co-chair

▲ Chairs of POMS 2021.





▲ Featured scholars and plenary speakers at POMS 2021: Prof. Hau Lee, Prof. Keskinocak, Prof. Chris Tang

Other special events included the biennial Applied Research Challenge organized by *Chris Tang* and *Felipe Caro*. *George Shanthikumar* provided several POMS tutorial sessions. Chris Tang also chaired a session dedicated to honouring *Hau Lee's* many contributions to the richness of theory and practice in POMS. *Kalyan Singhal*, founder of POMS and Editor-in-Chief of the journal *Production and Operations Management*, recounted the encouragement *Hau Lee* provided to launch the *Production and Operations Management Society* during 1989.

*Plenaries* were delivered by *Pinar Keskinocak* on "*Infectious Disease Modeling and Informed Decisions*"; and *Chris Tang* on "*Innovative Technology and Operations for Alleviating Poverty through Women's Economic Empowerment*".

Social and cultural events were also part of the online experience of POMS 2021 Conference. *Dr. Hall Murthy* provided a session on *Stress Management: Role of Physical and Mind*

*Exercises*. POMS members organized a cultural session with performances of dance, singing and music from around the globe.

To close the conference on May 5, 2021, POMS recognized organizers of international meetings as well as POMS 2021 Conference-Online program committee members and other volunteers.

The online conference platform was developed and supported by Tenex Software Solutions, Tampa, Florida, USA. For more information about the Production and Operations Management Society, please visit <https://www.poms.org/>.

**Jerry Burke**, V.P. of POMS Meetings, is Professor and Chair, Georgia Southern University, Department of Logistics and Supply Chain Management. 🌐

## Khalifa University Successfully Hosted ICVNS 2021 - from Abu Dhabi, UAE, Online

**Erica Solomon** <[erica.solomon@ku.ac.ae](mailto:erica.solomon@ku.ac.ae)>

*This article is a modified version of an article by Khalifa University published on the KU News Website and is reprinted with permission from Khalifa University's Office of Marketing and Communications.*

Khalifa University and its Research Center for Digital Supply Chains and Operations Management successfully hosted the 8th International Conference on Variable Neighborhood Search (ICVNS 2021) from March 22-24, 2021, following the series of previous ICVNS conferences that were held in Rabat, Morocco (2019), Sithonia, Halkidiki, Greece (2018); Ouro Preto, Brazil (2017); Malaga, Spain (2016); Djerba, Tunisia (2014); Herceg Novi, Montenegro (2012); and Puerto de la Cruz, Tenerife, Spain (2005).



▲ ICVNS 2021: main page and logo.

Like its predecessors, the main goal of ICVNS 2021 was to provide a stimulating environment for researchers from various scientific fields to share and discuss their knowledge, expertise, and ideas related to VNS Metaheuristics and its applications.



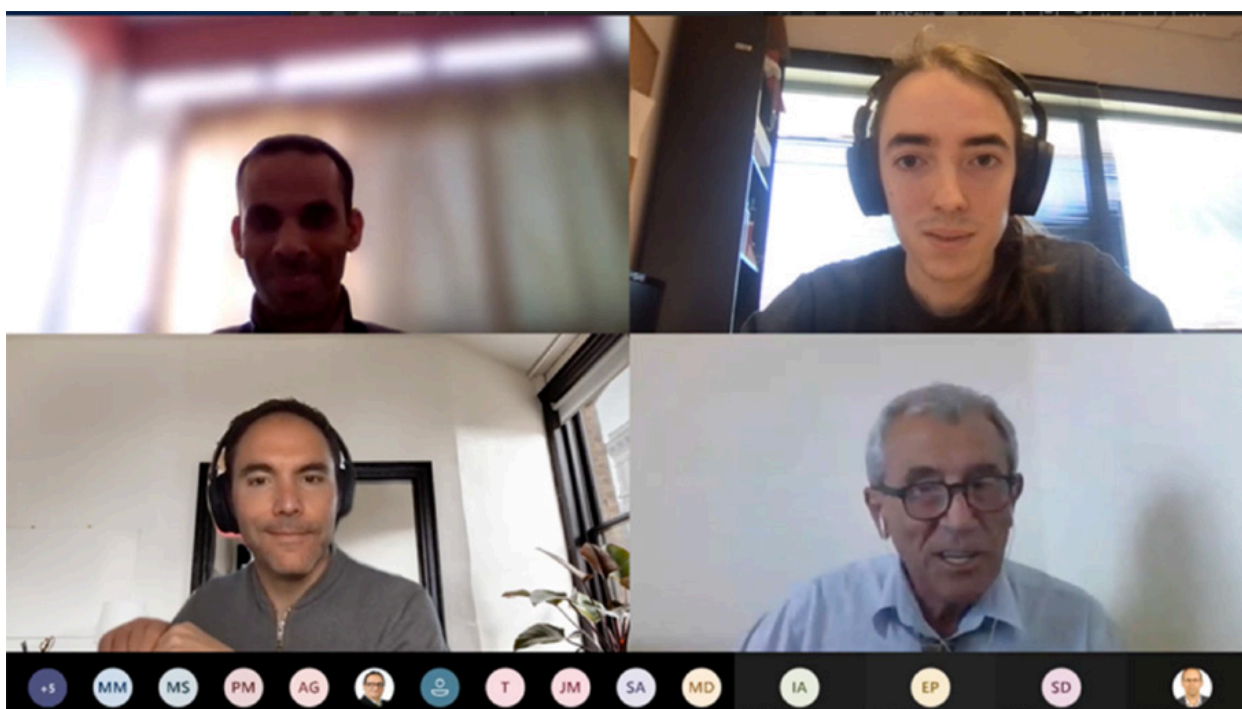
▲ ICVNS 2021: screenshots from 2 presentations.

Three plenary lecturers shared their current research directions during the three-day event. Prof. Panos M. Pardalos of the University of Florida's Department of Industrial and Systems Engineering discussed "VNS for Hard Optimization Problems and the Power of Heuristics". Prof. Yury Kochetov of the Sobolev Institute of Mathematics, Russia, talked about the "VNS Approach for Bilevel Discrete Optimization". Lastly, Prof. Bassem Jarboui from the Higher Colleges of Technology, UAE, tackled the topic of "VNS from Optimization to Machine Learning". Dr. Nenad Mladenovic, Professor of Industrial and Systems Engineering at Khalifa University, also conducted a Pre-ICVNS 2021 Tutorial introducing VNS Metaheuristics to new-comers and students.

32 papers were accepted for oral presentation during the conference. After a thorough peer-review by the members of the ICVNS 2021 Program Committee, 14 long papers were chosen for publication in the Springer Lecture Notes in Computer Science (LNCS) series. These papers describe recent advances in methods and applications of VNS. Post conference special issues are planned to be published in Optimization Letters, Yugoslav Journal of Operations Research, and MDPI: Symmetry.

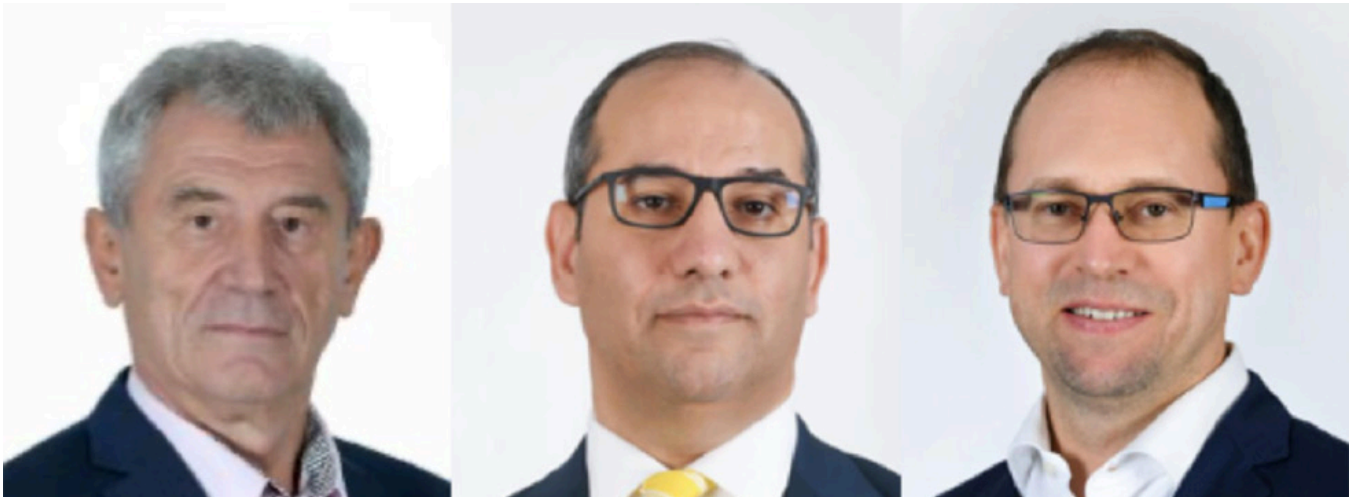
The success of the conference organization was further validated by the fact that the participants, PC members and previous organizers, proposed the next meeting to be organized again by Khalifa University and the Research Center for Digital Supply Chains and Operations Management, hopefully an in-person one.

The conference's Organizing Committee expresses gratitude to all the participants and PC members for their contributions and continuous effort to disseminate VNS. It says: "We are grateful to the reviewers for preparing excellent reports. The committee would also like to acknowledge the editorial staff of Springer LNCS for their support during the entire process of making this volume. And finally, the organizing committee would like to express their gratitude to the sponsors and co-organizers of ICVNS 2021, namely the EURO Working Group on Metaheuristics (EWG EU/ME), the Research Center for Digital Supply Chains and Operations Management at Khalifa University, KU's Marketing and Communications Department, and the Department of Culture and Tourism of Abu Dhabi. Their support is greatly appreciated for making ICVNS 2021 a great scientific event."



▲ ICVNS 2021: screenshot of a discussion; from left to right, and up to down: Rachid Benmansour (Insea, Morocco), Raul Martin Santamaria and Jose Manuel Colmenar (Universidad Rey Juan Carlos, Madrid, Spain) and Nenad Mladenovic (KU, UAE).





▲ Conference Chairs at ICVNS 2021 (from left to right): Prof. Dr. Nenad Mladenović, Prof. Dr. Mohammed Omar and Dr. Andrei Sleptchenko, all from Industrial and System Engineering, KU, UAE.



☰

## PLENARY SPEAKERS

---



**Prof. Panos Pardalos**  
University of Florida, USA



**Prof. Yury Kochetov**  
Sobolev Institute of Mathematics, Russia



**Prof. Bassem Jarboui**  
Higher Colleges of Technology, U.A.E.

▲ ICVNS 2021: Plenary Speakers; information on the main webpage.

More information about the *8th International Conference on Variable Neighborhood Search*, including recorded videos of selected talks, can be found on the conference website: <http://icvns2021.info/>. The *Organizing Committee* would also like to invite all VNS enthusiasts to participate in the indicated special issues, here: <http://icvns2021.info/#about>.

*Khalifa University of Science and Technology* is an internationally top-ranked research-intensive university located in Abu Dhabi, UAE. It boasts three colleges, three research institutes, 18 research centers, and 36 departments covering a broad range of disciplines in science, engineering, and medicine. *KU* is the one university in the UAE with the research and academic programs that address the entire range of strategic, scientific and industrial challenges of the 21st century. *KU's* world-class faculty and state-of-the-art research facilities provide an unparalleled learning experience to students around the world. The university brings together the best in science, engineering and medicine in the UAE, to offer specialized degrees that can take promising high school graduates all the way to top-rated doctorate degree holders.

*Research Center for Digital Supply Chain and Operations Management* is a faculty cluster, dedicated to scholarship and education on extended enterprise operations and its digital transformation. Our macro-level research aims to provide real-world, cutting edge focus on the digital transactions, management, and optimization in multiple domains (maritime logistics, production lines, health care delivery systems). The faculty center expertise in supply chain, data science and predictive analytics, along with digitally networked systems, to address the extended-enterprises as a nexus of integrated supply-chains, digital-operations management, and technology-ready human capital.

We intend to publicize our research projects, proposed methodologies, research agenda and our scientific output. We welcome your feedback and we are open to collaborate with a multi-disciplinary perspective that encompasses engineering, socio-economics, and systems design.

The author, **Erica Solomon**, is a member of the *Khalifa University Communication Team*. 🌐

# News from the EURO WISDOM Forum: “OR in the Energy and Transportation” Webinar and the YoungWomen4OR presentations

**Paula Carroll** <paula.carroll@ucd.ie> **Annunziata Esposito Amideo** <annunziata.espositoamideo@ucd.ie>  
**Tatiana Tchemisova** <tatiana@ua.pt> **Ozgen Karaer** <okaraer@metu.edu.tr>



▲ 2nd YoungWomen4OR presenters (from left to right): Dr Alina Gabriela Dragomir, Dr Annarita De Maio, Dr Lavinia Amorosi, Dr Martina Fischetti, and Dr Meltem Peker Sarhan.

The *EURO WISDOM* (Women In Society: Doing Operational Research and Management Science) Forum organized the *Second YoungWomen4OR Webinar* via ZOOM on May 31, 2021.



▲ YoungWomen4OR Webinar subject matter expert: Prof David Pisinger

The webinar was organized by the *WISDOM* event subcommittee and moderated by *Paula Carroll*, the *EURO WISDOM* Chair, who opened the webinar with a brief overview of the activities and events of *WISDOM* in 2021.

Five *EURO WISDOM* YoungWomen4OR awardees provided lightning 5 minutes long talks sharing details about themselves and their research. Details on the presentation title and the researcher who provided it are reported as follows: “*Concepts for solving*

*large-scale routing problems*” by Dr Alina Gabriela Dragomir, University of Vienna, Austria; “*The Multi-Depot Inventory Routing problem in a mega-city environment*” by Dr Annarita De Maio, University of Calabria, Italy; “*New optimization problems on networks with emerging technologies*” by Dr Lavinia Amorosi, Sapienza University of Rome, Italy; “*Operations research for future wind farms: an industry perspective*” by Dr Martina Fischetti, System Design Department, Vattenfall BA Wind, Denmark, and “*Assessing Flexibility of Residential Demand Response under Uncertainty in Distribution Network*” by Dr Meltem Peker Sarhan, Newcastle University, UK.

After the YoungWomen4OR presentation, Prof David Pisinger, in his role as subject matter expert, presented a short overview of the current challenges in the OR for energy and transportation sectors

and suggested potential synergies with existing work. Prof David Pisinger is a Professor of Management Engineering at the Technical University of Denmark (DTU) with research interests spanning Maritime Optimization, Railway Optimization, and Energy.

Then, a moderated open discussion for networking opportunities followed. Participants, around 30, were allocated to three different breakout rooms, where they actively participated in discussions on different topics such as the role of women in OR in academia and beyond, how to support the role of women in OR; opportunities, possibilities, and difficulties that young people face at the early stage of their careers; and potential research collaborations. The challenges caused by the actual pandemic situation as well as the changes it brought to everyone’s life were also discussed.

The webinar ended with Prof David Pisinger suggesting YW4OR to start collaboration, to draft something together, and the emerging idea of a “buddy” scheme rather than a more formal mentoring scheme from one generation of YW4OR to the other.

## Future WISDOM Events

The next YoungWomen4OR talk on OR: *Supply Chains and Logistics*, will take place on September 27, 2021, 15.00-16.30 (Central European Standard Time). 🌐



▲ 2nd YoungWomen4OR Webinar: a discussion in one of the discussion rooms



# “Optimal Control Problems Arising in Forest Management”

by Alexander J. Zaslavski (Technion, Haifa, Israel)

Springer Briefs in Optimization. Cham: Springer

(ISBN 978-3-030-23586-4/hbk; 978-3-030-23587-1/hbk /ebook). xiv, p. 136 (2019)

<https://www.springer.com/gp/book/9783030235864>.

## OR for Management of Tomorrow - Revisited

Gerhard-Wilhelm Weber <gerhard-wilhelm.weber@put.poznan.pl> Joanna Majchrzak <joanna.majchrzak@put.poznan.pl>

This work by *Alexander J. Zaslavski* focusses on an investigation of optimal control problems arising in *forest management*, an important and fascinating subject of mathematical economics investigated by many scientists over previous decades. This book inquires the forest management problem by analyzing a class of optimal control problems which embeds it and demonstrating the existence of optimal solutions over an infinite horizon. It also explores the structure of approximate solutions on finite intervals as well as their turnpike properties, the stability of the “turnpike” condition, and the structure of approximate solutions on finite intervals in neighborhoods around the end points.

In the weeks when this report was prepared, devastating fires raged in many parts of the world, for example in the Mediterranean region. Those consisted especially of forest fires and were spread all over the fields, villages and towns. This shows once again the great need for a very efficient, intelligent OR-supported forest management.

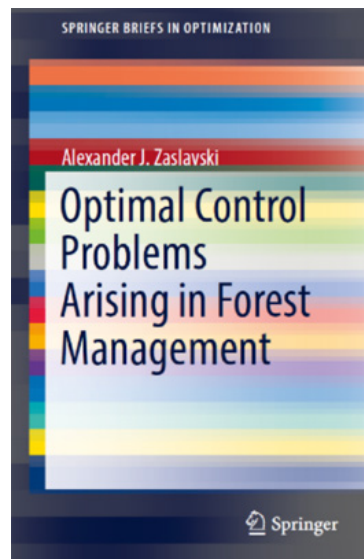
The book is a valuable contribution to optimal control, its theory, methods and applications, on the particular sub-discipline where the dynamics is time-discrete. In this field, optimal control meets with (i) linear and nonlinear optimization, (ii) discrete, combinatorial mathematics, and - in the future - it could be based on and learning by: (iii) data mining, analytics, statistical learning, machine and deep learning and, eventually, artificial intelligence with its emerging foundations.

This work is written clearly and it is rigorous in theory, while always being practically meaningful – with special emphasis on the very interesting, appealing and touching application field of *forest management*. In this iconic field, business and nature are viewed at the same time, such that questions about life quality and the future of mankind come into the mind of any reader quite soon. In literature, the forest management problem is investigated separately, not as a particular case of general models of economic dynamics. In this book the author studies the forest management problem by analyzing a class of optimal control problems which contains, as a particular case, the forest management problem. Extension to other areas of economy and ecology seems possible and likely.

This novel and unique book appeared with several benefits for the possible reader, especially: *i*. It develops the turnpike

theory for optimal control problems arising in the forest management, *ii*. It establishes the existence of solutions of infinite horizon optimal control problems arising in forest management, *iii*. It describes structure of approximate solutions on finite intervals in the regions close to the end points.

The 6 chapters of this book are these: 1. Introduction, 2. Infinite Horizon Optimal Control Problems, 3. Turnpike Properties, 4. Generic Turnpike Properties, 5. Structure of Solutions in the Regions Close to the Endpoints, 6. Applications to the Forest Management Problem.



▲ *Management of Tomorrow. with Operational Research in forestry.*

How did the discourse continue after the book became published, which discussions did it initiate, which new challenges did it encounter, especially during our 2 years on pandemic COVID-19, where did the development take us in humankind, in our relations to natural environment and especially forestry? Of particular interest have been these 3 questions: (a) Could we advance and later on use the methods of this book for “fisheries”, “agriculture”, “renewable resources” and “education”, as they are seeded, planted, nurtured and harvested, too, namely by branches of economy and society and our whole civilization? (b) Could aspects and objectives, criteria and constraints on “biodiversity” be included into this study, with respect to forests and the further fields named in (a)? This will also lead to studies on “trophic cascades”, to questions

of our lifestyle and our nutrition, to possible related pandemics in the future, to our destruction or preservation of the forests, to all the implications for climate on earth. (c) Could we bring ahead “random” or “stochastic” versions of study based on this book? The author, Alexander J. Zaslavski, is very much positive and convinced here by stating:

*“I believe that the turnpike phenomenon holds and can be studied in all these cases with a close approach in general but probably with different concrete tools depending on the model.”*

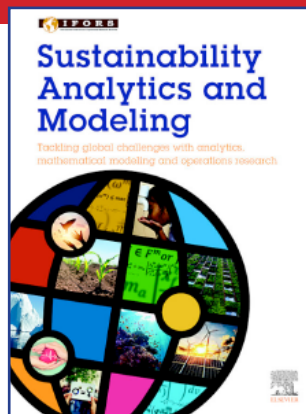
Based on this monography, in forthcoming years, enthusiasts and communities of mathematics, economics, OR and the environmental sciences can become well introduced into this important subject. Further research and real-world applications may be made by them, for the sake of emerging “green” industries, of nature and biosphere, and of the living conditions of us humans.

This beautiful monograph was first intended for mathematicians interested in the optimization theory, optimal control and their use on economic theories - but for many others, too. It is written care- and tastefully, well structured, deep, and well exemplified. We authors believe that a comparison and combination between optimal control, simulation theory and notably the *OR* methodology of “*system dynamics*” could be a fruitful agenda of research, refinement of methodological toolbox and application.

In following years, further advances and extensions may be prepared by the author and within the academic family of optimization, optimal control and OR; they may be initiated, fostered and supported by this book. These could be made in theory, methods and applications, and may be related to continuous and “hybrid” (discrete-continuous) problems as well, benefitting from continuous-time optimal control, singularity

and Morse theory, robust optimization, stochastic optimal control, discretization schemes, and elements like thresholds, regime switching, hybrid (Boolean or stochastic) systems, as well as collaborative games and stochastic games. Such future works could also be on management in agriculture, fisheries, and all the aforementioned areas of growing and “harvesting” skills and competences, where the author’s settings have been approved by him to be useful as well. This is even truer, given the increasing number of future uncertainties in our regime-switching economies and generalized space-time environments and paradigm-shifting cultures, and the growing demand for premium research of high relevance. Such emerging advances could enable researchers to progress in management, economics and finance, in bio- and medical sciences, in environmental and geo-sciences, natural sciences and astronomy, in societal and developmental sciences, cultures of narration and the arts. 🌍

## Call for Papers



### IFORS/Elsevier Sustainability Analytics and Modeling

#### Special Issue: Sustainability in Retail Supply Chains Making a better world in retailing from sourcing to consumption

#### 1. AIMS AND SCOPE

Retail supply chain management has emerged as a substantial area of research in recent years. Retailing is a significant sector of the economy in which changes in markets, firms, processes and products occur rapidly. The retail industry has been a thought leader in the development and design of advanced operations concepts and processes since the 1990s. Many different retailers from grocery to fashion retailing and consumer electronics have developed operational innovations, many of which have been adopted in other industries. However, still many sustainability issues remain in global retail supply chains. For example, less than 1% of retail revenues is paid to workers in production factories and some workers in retail supply chains are exposed to modern slavery. Other issues arise from the waste streams in retail. About one third of produced food goes uneaten. Less than 10% of plastic waste from retail is currently expected to be recycled. Increasing energy, traffic congestion and CO2 emissions from home delivery, and raw material needs, along with ongoing product proliferation, calls for more sustainable retail supply chains.

Analytics and modeling has the potential to enhance the economic, environmental and social sustainability in retail supply chains. The objective of this special issue is to accelerate the development and application of quantitative approaches for problem-solving and decision-making to further develop sustainable retail operations. The primary aim of this special issue is to create an outlet for such research efforts. Methods should include operations research, quantitative modeling and/or analytical approaches that fit the scope of the journal. Topics should be based on industry background of retail or

consumer goods and can include concepts from production to consumption.

#### 2. TOPICS COVERED

Sustainability Analytics and Modeling publishes articles that develop and apply quantitative methods of analytics and operations research to take on global sustainability challenges. These challenges are many and broad in scope. They involve poverty, hunger, health, well-being, education, equality, water, sanitation, energy, economies, industry, infrastructure systems, smart communities, consumption and production, climate, peace, and justice, among other topics, all of which are targeted by the 17 sustainable development goals (SDGs) of the United Nations (<https://www.un.org/development/desa/disabilities/envision2030.html>). Topics that are of interest for this special issue include, but are not limited to:

- Combining social, environmental and economic perspectives in retail supply chains;
- Options to reduce food losses and waste along the supply chain;
- Concepts of circular economy in retailing (e.g., in consumer electronics and fashion);
- Advanced inventory management in retail supply chains to reduce losses and overstocking;
- Social and environmental impact of retail digitalization, omni-channel retailing and new business models in retail services (e.g., food services);
- New strategies for product launches and product proliferation;
- Increasing transparency in international supply chains and manufacturer-retailer cooperation;
- Innovative distribution concepts (e.g., omnichannel retailing) and its impact on sustainability;



- Last mile delivery concepts and their environmental impacts;
- Pandemic impact on retail operations and supply chains; and
- Interface of retail operations with other functions such as finance, human resources, marketing, and strategy to increase company sustainability.

### 3. SUBMISSION GUIDELINES

The APC (Article Publishing Charge) will be covered by IFORS for all papers submitted by 31st December 2022. Submitted papers should be original works and should not have been previously published or currently considered for publication elsewhere. The manuscripts should be prepared according to the Guide for Authors available at:

<https://www.elsevier.com/journals/sustainability-analytics-and-modeling/2667-2596/guide-for-authors>.

All manuscripts should be submitted electronically using the journal's online manuscript submission system at: <https://www.editorialmanager.com/samod/default.aspx> when prompted for the article type, please select, "VSI: Retail Supply Chains".

On the Attach Files screen, please submit the Manuscript, Highlights, Cover Letter summarizing the contributions of the paper, and Conflict of Interest Declaration (template available at [https://service.elsevier.com/app/answers/detail/a\\_id/286/supporthub/publishing](https://service.elsevier.com/app/answers/detail/a_id/286/supporthub/publishing)).

At the Review Preferences screen, you may suggest potential reviewers for this submission and provide specific reasons for your suggestion in the comments box for each person.

Manuscripts submitted after the deadline may not be considered for the special issue and may be transferred, if accepted, to a regular issue.

### 4. IMPORTANT DATES

Eligible submissions will be quickly submitted to the peer review process by the guest editors. The guest editors will work to ensure a maximum time of three months for the initial peer review process. Accepted papers will be published online quickly after acceptance, so that papers submitted early will also be published well ahead of the special issue's scheduled publication date.

Beginning of submissions: January 1, 2022

Deadline for submissions: July 1, 2022

Targeted closure of first peer review process: September 30, 2022

Publication: Early 2023

### GUEST EDITORS

#### Alexander Hübner

Technical University of Munich  
Campus for Sustainability and Biotechnology  
Am Essigberg 3  
94315, Straubing, Germany  
e-mail: [alexander.huebner@tum.de](mailto:alexander.huebner@tum.de)

#### Heinrich Kuhn

Catholic University of Eichstätt-Ingolstadt  
Department of Operations and Supply Chain Management  
Auf der Schanz 49  
85049 Ingolstadt, Germany  
e-mail: [heinrich.kuhn@ku.de](mailto:heinrich.kuhn@ku.de)

#### Gerhard-Wilhelm Weber

Faculty of Engineering Management  
Poznan University of Technology  
ul. Jacka Rychlewskiego 2.  
60965 Poznań, Poland  
e-mail: [gerhard.weber@put.poznan.pl](mailto:gerhard.weber@put.poznan.pl) 🌐

## Sustainability Analytics and Modeling

### Special Issue:

## Frontier Methods for Sustainability Challenges

### 1. AIMS AND SCOPE

The assessment and promotion of sustainable development is an issue with growing importance among scientific and policy-making communities. Efforts from the academy and governmental institutions lead to a better understanding of how local communities, industries, cities, and countries are performing compared to their peers and encouraging the monitoring of progress over time. In recent years, efforts to monitor these components have generated many indicators intended to measure performance on aspects about emissions, waste production, green space, safety, income, health, education, etc. Countries and supranational organizations collect data on these indicators. Still, the amount of data generated is often too large, and it is not sufficiently clear to provide helpful information and practical guidance to attend to the needs of the policymakers. Efforts to measure and quantify the results of policies aiming at sustainable development improvements are necessary to guide decision-making. Thus, there remains a need for advancing existing tools and designing new ones for promoting sustainability improvements. This special issue aims to explore and advance Frontier Methods' latest achievements to tackle sustainability

challenges by publishing articles that address topics, such as:

### 2. TOPICS COVERED

The topics include but are not limited to:

- Theoretical developments of frontier estimation models addressing sustainability challenges
- Innovative applications of Data Envelopment Analysis and Stochastic Frontier Analysis to Sustainable Development challenges
- Quantitative methods targeting the assessment of the three pillars of Sustainable Development: People (social sustainability), Planet (environmental sustainability), and Prosperity (economic sustainability)
- Assessments focused on the Sustainable Development Goals of the UN Agenda 2030.
- Cross-national comparisons in the examination of sustainable development
- Theoretical and methodological challenges in understanding the determinants of sustainable development in the key sectors (e.g., education, health, justice, water and sanitation, energy, or others)

•Convergence in the achievement of Sustainable Development at regional, national, or worldwide level

### 3. SUBMISSION GUIDELINES

The APC will be covered by IFORS for all papers submitted by 31st December 2022. Submitted papers should be original works and should not have been previously published or currently considered for publication elsewhere. The manuscripts should be prepared according to the Guide for Authors available at:

<https://www.elsevier.com/journals/sustainability-analytics-and-modeling/2667-2596/guide-for-authors>.

All manuscripts should be submitted electronically using the journal's online manuscript submission system at:

<https://www.editorialmanager.com/samod/default.aspx>.

When prompted for the article type, please select "**Special issue on Frontier Methods for Sustainability Challenges**".

On the Attach Files screen, please submit the Manuscript, Highlights, Cover Letter summarizing the contributions of the paper, and Conflict of Interest Declaration (template available at [https://service.elsevier.com/app/answers/detail/a\\_id/286/supporthub/publishing/](https://service.elsevier.com/app/answers/detail/a_id/286/supporthub/publishing/)).

In the review preferences screen, you may suggest potential reviewers for this submission and provide specific reasons for your suggestion in the comments box for each person.

Manuscripts submitted after the deadline may not be considered for the special issue and may be transferred, if accepted, to a regular issue.

### 4. IMPORTANT DATES

31 December 2021	Submission deadline	
1 April 2022	Notification of the first round review	(for guidance only)
1 June 2022	Revised submission due	(for guidance only)
1 August 2022	Final notice of acceptance/reject	(for guidance only)

Papers will be subject to a review process managed by the

Guest Editors. The primary acceptance criteria for submission are the quality and originality of the research, the paper's analytical contributions, and the relevance of the research topic.

Early submission is encouraged. The referee process will start upon submission of the paper. Accepted papers will be published individually online as they are accepted, before print publication. All inquiries concerning the submission to the special issue will be addressed directly by the Guest Editors.

### GUEST EDITORS

#### Prof. Ana Camanho

Department of Industrial Engineering and Management  
University of Porto

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

e-mail: [acamanho@fe.up.pt](mailto:acamanho@fe.up.pt)

#### Dr. Giovanna D'Inverno

Faculty of Economics and Business  
KU Leuven

Naamsestraat 69, 3000 Leuven, Belgium

e-mail: [giovanna.dinverno@kuleuven.be](mailto:giovanna.dinverno@kuleuven.be)

#### Prof. Dr. Rossana Riccardi

Department of Economics and Management  
University of Brescia

Via San Faustino 74/b, 25121 Brescia, Italy

e-mail: [rossana.riccardi@unibs.it](mailto:rossana.riccardi@unibs.it)

#### Dr. Hervé Dakpo

Université Paris-Saclay, INRAE, AgroParisTech, Economie Publique

78850, Thiverval-Grignon, France

Email: [k-herve.dakpo@inrae.fr](mailto:k-herve.dakpo@inrae.fr)

#### Prof. Dr. Gerhard-Wilhelm Weber

Faculty of Engineering Management  
Poznan University of Technology

ul. Jacka Rychlewskiego 2.

60965 Poznań, Poland

e-mail: [gerhard.weber@put.poznan.pl](mailto:gerhard.weber@put.poznan.pl) 🌐



# NEWS

Editor in Chief: Sunity Shrestha Hada

Regional Correspondents	
ALIO	Rosiane de Freitas
APORS	Degang Liu
EURO	Gerhard Wilhelm Weber, Sarah Fores
NORAM	Grace Lin, Melissa Moore

Section Editors	
OR Impact	Sue Merchant/John Ranyard
OR for Devt	Rosiane de Freitas Rodrigues
Tutorial	Javier Marengo
Conferences	Gerhard Wilhelm Weber

Country Correspondents	
Argentina	Javier Marengo
Australia	Erhan Kozan
Austria	Karl Doerner
Belarus	Vladimir Golovko

Brazil	Caroline Mota
Canada	Dionne Aleman
Chile	Victor Albornoz
China	Degang Liu
Colombia	Elena Valentina Gutierrez
Croatia	Snjezana Pivac
Czech Republic	Jaroslav Ramik
Denmark	Sanne Wohlk
Finland	Jussi Hakanen
France	Luce Brotcorne
Germany	Brigitte Werners
Greece	Evangelos Grigoroudis
Hungary	József Temesi
India	N.M. Ganguli
Iran	Nezam Mahdavi-Amiri
Ireland	Cathal Brugha
Israel	Michal Tzur
Japan	Jun-ya Gotoh
Korea	Chang Won Lee

Lithuania	Leonidas Sakalauskas
Malaysia	Ilias Mamat
Mexico	Yasmin Rios
Nepal	Sunity Shrestha Hada
New Zealand	Andy Philpott
Norway	Marielle Christiansen
Netherlands	LCM Kallenberg
Peru	Orestes Cachay Bosa
Philippines	Elise del Rosario
Poland	Jan W. Owsinski
Portugal	Ana Carvalho, Tânia Ramos
Slovenia	Lidija Zadnik-Stirn
South Africa	Martin Kidd
Spain	Juan-José Salazar-González
Sweden	Tomas Gustafsson
Tunisia	Taïcir Loukil
UK	John Hopes
USA	Jim Cochran
Uruguay	Carlos Testuri