

# IFORS

## NEWS

### International Federation of Operational Research Societies

## From the President

### Equity, Diversity and Inclusion

**Grazia Speranza** <grazia.speranza@unibs.it>

The IFORS Administrative Committee recently approved a 'Equity, Diversity and Inclusion Policy Statement' and a 'Gender Equity Commitment'. In the former document fundamental principles regarding the founding values of our Federation and the support and promotion of equity, diversity and inclusion are stated. In the latter document, IFORS commits to more specific lines of action to ensure that gender equity is appropriately embedded and prioritised. You can find the two documents in this newsletter.



We are scientists and belong to an international community that is diverse in several ways. We know diversity is a richness and we keep learning from each other by reading each other's paper, by listening to each other's talk at conferences. We respect each other and each other's work. This is, in few words, the message delivered through the 'Equity, Diversity and Inclusion Policy Statement'. The 'Gender Equity Commitment' makes one step more ahead to make the statement closer to actions. By approving these documents, IFORS has joined the large group of companies, institutions and organizations that have adopted similar statements and commitments.

Science has always played a role of fighting injustice and supporting peace and respect. We, as operational researchers, can contribute to this also today. I hope that the adoption of these documents will stimulate a discussion within the IFORS member societies that will lead them to adopt the documents or similar ones and disseminate them to their members.

With the forthcoming end of 2021 I am approaching the end of my term as IFORS President. This is my last editorial and I am pleased I could focus it on the founding values and principles that will continue to inspire IFORS and the entire international community it represents. These three years have been intense and rewarding. I had the pleasure and honour to work with an amazing group of colleagues. I wish to name them one by one: Mike Trick, the former President, David Chang Won Lee, the vice-President, Richard Hartl, the treasurer, Rosiane de Freitas, Sunity Shrestha Hada, Stefan Nickel, Karla Hoffman, representing the four regional groupings ALIO, APORS, EURO, NORAM, respectively. Our work has been professionally supported by Mary Magrogan and Christy Blevins. I am grateful to each of the members of this group for their commitment to IFORS and honoured by their friendship. Due to the pandemic we could meet in person only once. Nevertheless, I can say we have achieved some results that I hope will contribute to make the IFORS community stronger: we started a new journal on Sustainability Analytics and Modeling; we accompanied the IFORS2020 conference to become a virtual, and successful, conference in 2021; we started the series of the IFORS global webinars; we registered IFORS as an international organization in Switzerland; we established a new award: the IFORS fellows; we started regular remote meetings with Presidents and Representatives of the member societies; we worked with the African operational researchers in view of the creation of an African grouping; we redesigned the IFORS website; we expanded the newsletter.

I am grateful for the opportunity I was given. It has been an honour to be IFORS President and to serve, through IFORS, the international operational research community. 🌍

## What's Inside

- 1. From the President**  
Equity, Diversity and Inclusion
- 2. From the Editor-in-Chief**  
Sunity Shrestha Hada
- 3. IFORS Prize for OR for Development 2021**
- 4. OR and Development**
- 5. Tutorial**  
Submodular Optimization and the Greedy Algorithm
- 6. OR Impact**  
Promoting OR's Global Success in Solving Real Problems: Examples over the Last Decade
- 7. Conferences**
  - IJCA 2021
  - 18th Summer School in Risk Finance and Stochastics
  - 17th ESICUP Meeting
  - ICAME'21
  - Game Theory and Management GTM 2021
  - EWGT 2021
  - OR63 - The Annual Conference of The OR Society in the UK
  - ICAISD 2021
  - 8th HLF 2021
  - ICO 2021
  - EURO 2021
  - USNA 2021
  - ORSSA/AFROS Conference 2021
  - ORSP Webinar 2021
- 8. Triennial IFORS Conference 2021 report by KORMS**
- 9. Book Review**
- 10. ITOR Best Paper Award 2021**
- 11. Editorial Box**

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



The December issue of 2021 is ready now. At the end of 2021, term of all regional VP's to IFORS will be completed. The last three years for me as VP to IFORS representing APORS was an outstanding period of my life where I got responsibility of editor-in-chief of such a prestigious IFORS newsletter. As a regional VP and member of IFORS admin committee, there was so much to learn, gain and experience. This period is most memorable and satisfactory in my life. The team with Grazia Speranza, Michael Trick, Chang Won Lee, Richard Hart, Stefan Nickel, Karla Hoffman and Rosiane de Freitas had been very creative and productive. Working for the newsletter I got to know Gerhard Wilhelm Weber, Sue Merchant, John Ranyard, Javier Marenco as section editors and the webmaster Ruel Tan. The continuous effort of all of them made the job pleasant and successful.

In this issue we have all the permanent features such as OR and Development, OR Impact 'Promoting OR's global success in solving real problems: examples over the last decade', the Tutorials 'Submodular Optimization and the Greedy Algorithm' and reports on OR Conferences happening throughout the world is collected and edited by Gerhard-Wilhelm Weber. The book "Inventory Analytics" written by Roberto Rossi is reviewed by Gerhard-Wilhelm Weber and Selma Gütmen. This issue also include the report on the Award for OR Development which is contested and awarded during the triennial IFORS conference 2021. The report on ITOR awards has been written by Celso Ribeirois.

In addition to all the articles on permanent section, the report on the IFORS triennial conference held in South Korea in hybrid mode is reported by the organizing committee chairperson SUK-GWON Chang.

As the world is getting out of the COVID-19 fear, programs are conducted in hybrid mode, let us hope that in near future it will be possible to organize 100 percent physical programs, and people will get chance to meet and work together.

Hoping for the better future of human being and the whole universe I extend the best wishes for the new year 2022. 🌍

## IFORS Prize for OR for Development 2021

### WINNER

JalTantra: Impacting the Practice of Rural Water Network Design in India

### Authors:

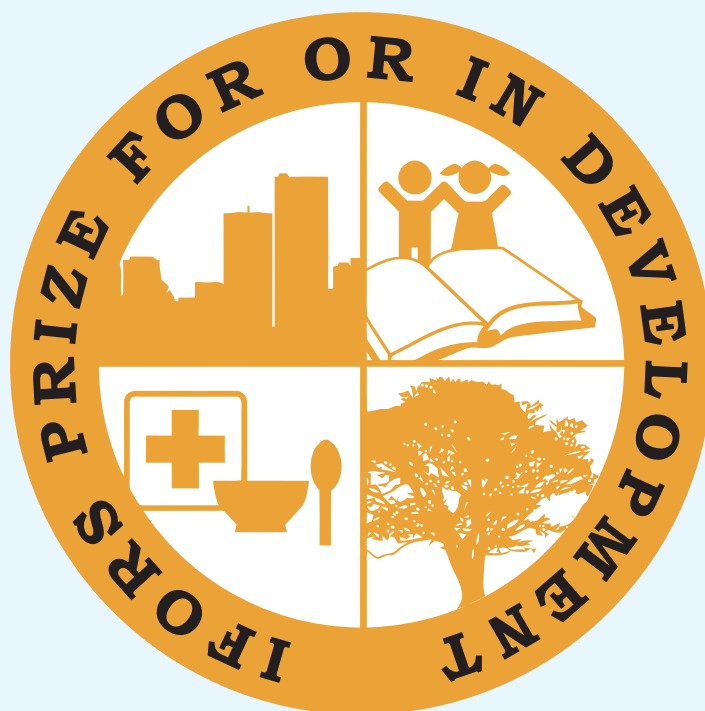
Nikhil Hooda - IIT Bombay, India  
Om Damani - IIT Bombay, India  
Ashutosh Mahajan - IIT Bombay, India

### RUNNER-UP

School Choice in Chile

### Authors:

José Correa - Universidad de Chile, Chile  
Rafael Epstein - Universidad de Chile, Chile  
Juan Escobar - Universidad de Chile, Chile  
Ignacio Rios - Stanford University, USA  
Bastián Bahamondes - Universidad de Chile, Chile  
Carlos Bonet - Columbia University, USA  
Natalie Epstein - Universidad de Chile, Chile  
Nicolás Aramayo - Universidad de Chile, Chile  
Martin Castillo - New York University, USA  
Andres Cristi - Universidad de Chile, Chile  
Boris Epstein - Universidad de Chile, Chile  
Felipe Subiabre - Universidad de Chile, Chile

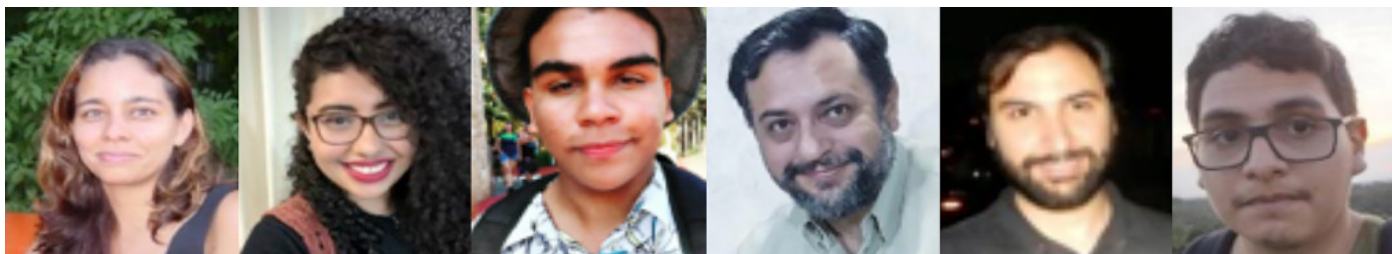


# 3D Molecular Reconstruction and Functional Analysis of SARS-CoV-2 Variants of Concern

Rosiane de Freitas <sup>(a)</sup>, Clarice Santos <sup>(a)</sup>, João Alfredo Bessa <sup>(a)</sup>, Kelson Mota <sup>(b)</sup>, Jonathas Nunes <sup>(b)</sup>, Micael Davi Oliveira <sup>(b)</sup>

<sup>(a)</sup>Optimization, Algorithms and Computational Complexity CNPq Research Group. Institute of Computing, Federal University of Amazonas (IComp/UFAM), Manaus-AM, Brazil

<sup>(b)</sup>Laboratory of Theoretical and Computational Chemistry. Department of Chemistry, Federal University of Amazonas, Manaus-AM, Brazil

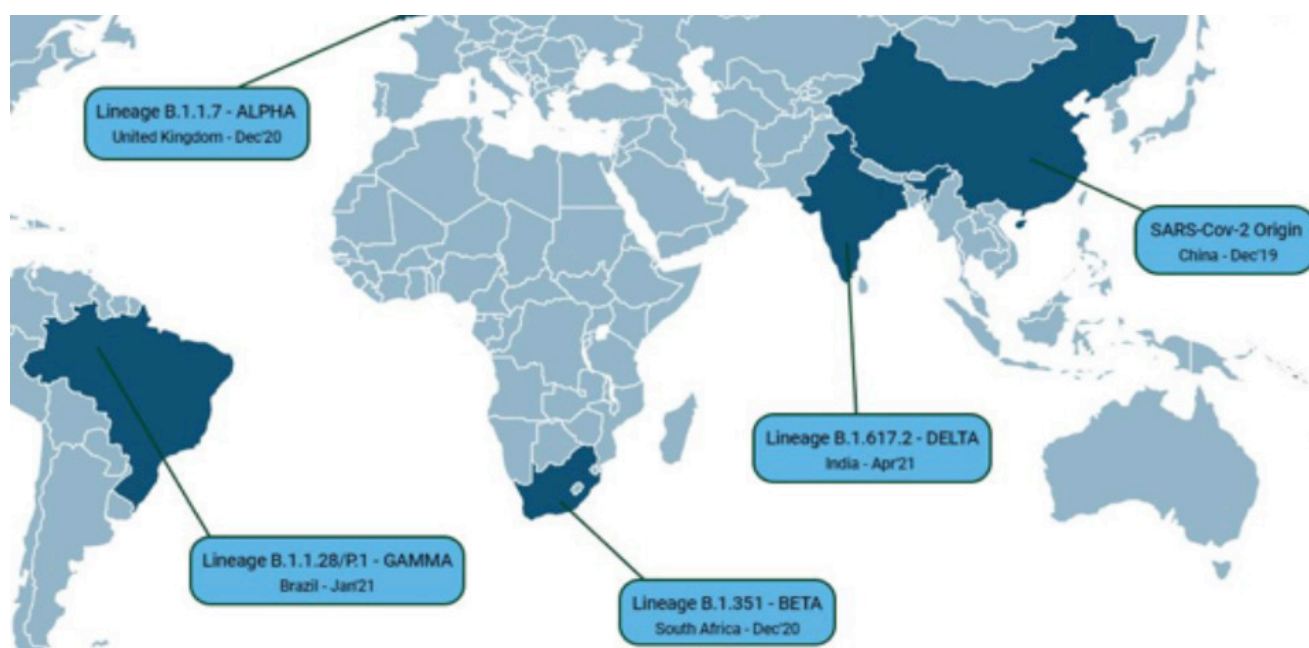


The most recent emerging strain is B.1.617.2 (Delta variant), which is considered worrying and is already circulating throughout the world, whose emergence was in the city of Maharashtra, India declared as Variant of Concern (VOC) by WHO on the 6th of May 2021. In addition, it was associated with a rapid increase in cases, with evidence for an increase in viral transmissibility. Through preliminary studies, there was greater difficulty in the immune defense mechanism induced by vaccination [1]. Research found that Delta is about 60% more infectious than the Alpha variant (B.1.1.7). In addition, there are already signs that the hospitalization rate leads to a more severe form of the disease [2]. Finally, it is important to highlight that it presents 2 (two) new mutations not present in the previous strains, in detail we have in the RBD region: L452R, T478K. In Figure 1 there is an illustration of the SARS-CoV-2 origin and the locations where the most worrying variants of the coronavirus emerged.

The Delta variant has been a major concern at the moment, although it is known that fully vaccinated people are likely to have protection against this variant. Furthermore, recent data indicate that vaccines are effective in preventing the most severe form of COVID-19 even in the face of the Delta variant

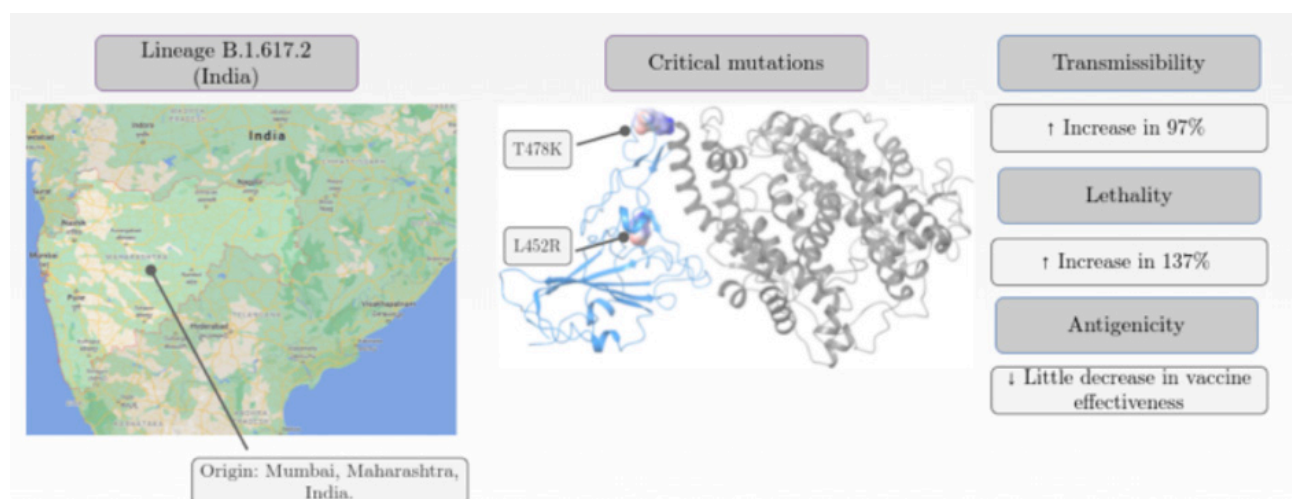
[3]. Therefore although neutralizing antibodies conferred by vaccines have greater difficulty in recognizing the antigen Spike as consequence of Delta variant, patients still had defenses against the virus [3]. Numerous studies show that COVID-19 vaccines, although they may lose some of their effectiveness, still provide immunity against novel variants of concern [4].

The spike protein is the key to how the virus interacts with the human cells, whether in the immune response but also when entering airway cells, and therefore this region is much more susceptible to mutations and consequently concerns about vaccine recognition. Each virus follows its own evolutionary theory, which can take years. In view of the new variants of concern of SARS-CoV-2, we realize that a large part of them increase the transmissibility and there are also signs of lethality. Throughout history, we have as an example the bacterium *Yersinia pestis* that caused the Black Death of 1346, which has not lost its high lethality rate [5]. It came to an end just seven years later, in this case because many unfortunately died. In contrast, the pathogen that caused the 1918 Spanish flu, evolved to become less deadly and ceased in 1920 [5]. >>



▲ Figure 1. Illustration of where the most worrying variants of the coronavirus emerged.





▲ Figure 2. Diagram illustrating the variant of concern Delta of SARS-CoV-2 virus.

>> Furthermore, extremely deadly viruses like Ebola tend to disappear quickly. However, regarding the SARS-CoV-2 virus, we still don't know exactly its evolutionary trajectory. Natural evolution generally favors increased transmissibility, since viruses that spread more easily provide greater adaptation to the host [5]. However, this is not a behavior that has been occurring in the worry variants, where the recent Delta variant presents a great increase in transmissibility, but also in mortality. An illustration can be seen in Figure 2 summarizing the impact on immunogenicity due to the Delta variant.

Due to the delay between obtaining the crystallography of a new variant, the existence of algorithms that can accurately predict the protein structure resulting from these variants is of paramount importance. The algorithm in this work, compared to the existing ones, employs a more efficient computational optimization method.

### Reconstruction of variants with Branch-and-Prune

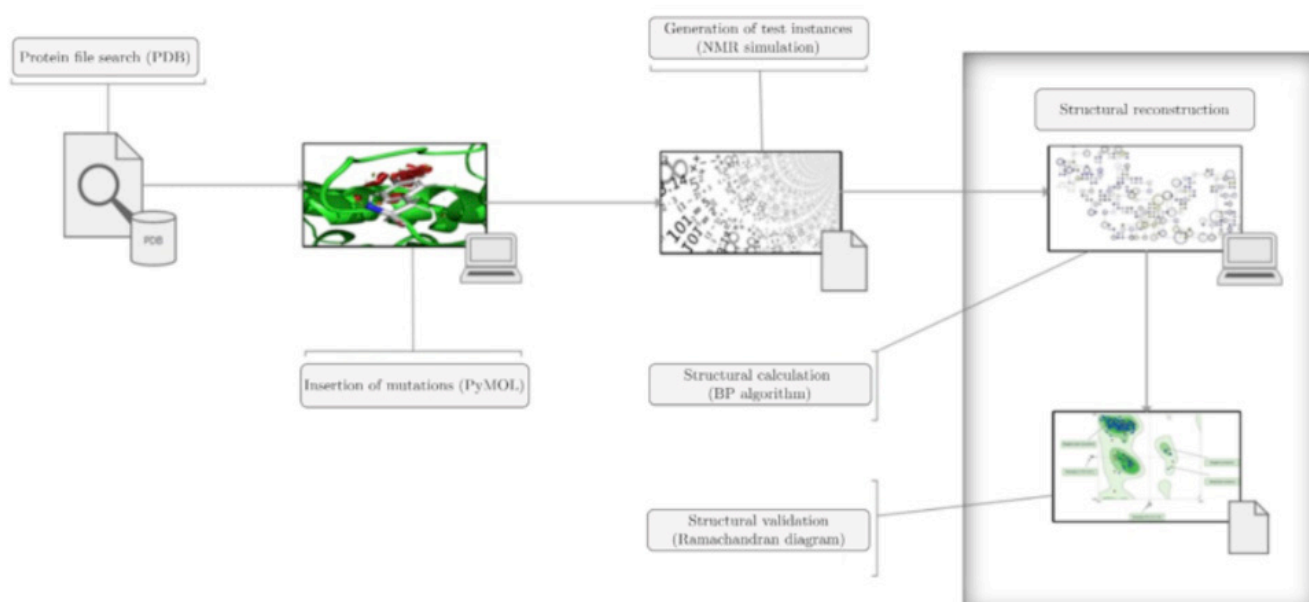
In the reconstruction of the Delta variant (see Figure 3), we applied the T478K and L452R mutations with the aid of the Schrodinger Maestro 2021-2 software, having as a starting point the structure without mutations of the Spike protein (PDB ID: 7OR9). Subsequently, we performed a minimization in the entire structure using the Prime algorithm in implicit

solvent with software Schrodinger Maestro 2021-2. And finally, we subset an instance of the Branch-and-Prune (BP) algorithm. In this way, finally the resulting structure in the algorithm was compared with the crystallographic reference of L452R (PDB ID: 7ORB) and T478K (PDB ID: 7ORA). One of our works carried out a similar approach [6], but focused on the P.1 variant that emerged in Brazil and with molecular dynamics approach [7],[8].

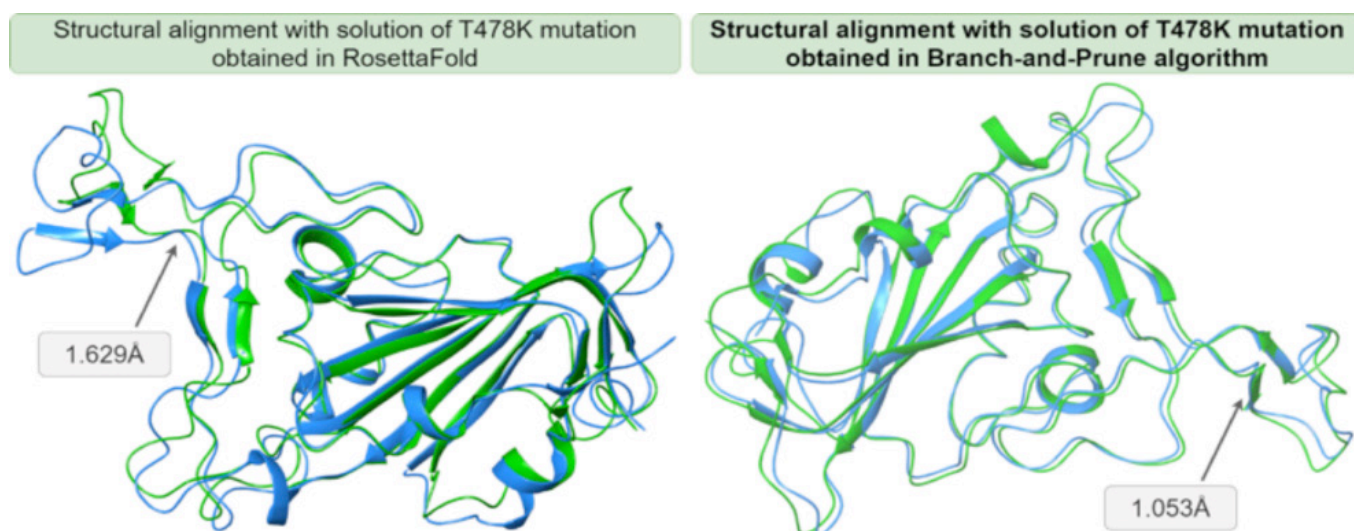
### Results of structural reconstruction

The structural alignment between the best solution for the L452R mutation and its crystallographic structure (PDB ID: 7OR9) resulted in an RMSD of 1.214Å. While for the T478K mutation (PDB ID: 7ORA), the overlap with the best solution resulted in an RMSD of 1.053Å. In Figure 4 we can see a comparison with an already consolidated algorithm, RosettaFold. Furthermore, in Figure 5 there is a comparison regarding the structural validation using a Ramachandran diagram.

Thus, the proposed algorithm is superior to many existing ones, due to a smaller structural alignment RMSD, but in the Ramachandran diagram it still showed some flaws therefore losing to RosettaFold. Thus, some limitations still exist, such as not accepting the amino acid sequence as input data. >>



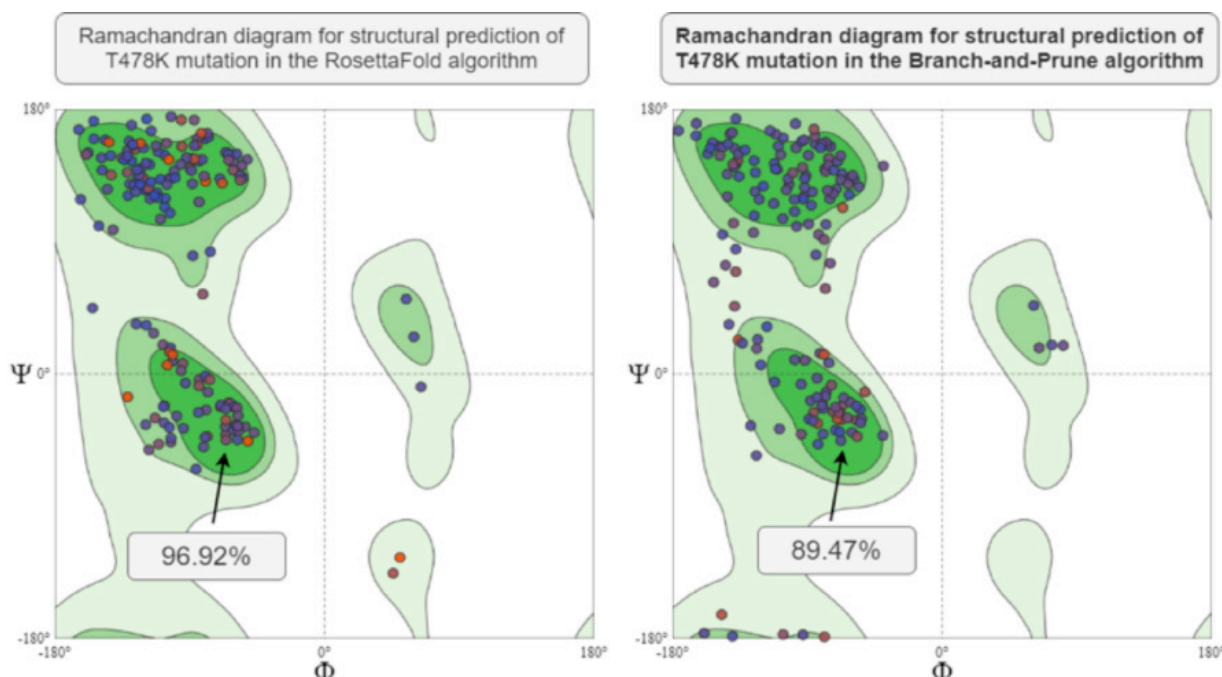
▲ Figure 3. Flow of structural calculation of SARS-CoV-2 strain proteins [6].



▲ Figure 4. Comparison between the Branch-and-Prune algorithm and the RosettaFold structural prediction software. The smaller the RMSD, the more efficient the algorithm.

>> Furthermore, structural minimization in external software is still necessary to overcome some imperfections in the algorithm. Other essential approaches are molecular dynamics simulations for structural minimization based on the solution returned by the algorithm. Therefore, it is a computational technique with diverse applications in biology and undoubtedly an important resource against COVID-19.

**Acknowledgements** We have sincere gratitude for all the people who came together to face this difficult period of COVID-19. We would like to thank the National Council for Scientific and Technological Development (CNPq) for supplying this research with grant 128869/2021-6. This study was financed in part by the Coordenação de Aperfeiçoamento de Pessoal de Nível Superior - Brasil (CAPES) - Finance Code 001.



▲ Figure 5. Structural validation using a Ramachandran diagram. The higher the percentage of amino acids in the sterically favorable region, the better the structural quality. All images were generated using the MolProbity algorithm belonging to the Swiss-Model platform (<https://swissmodel.expasy.org/assess>).

## References

- [1] M. Hoffmann et al., "SARS-CoV-2 variant B.1.617 is resistant to bamlanivimab and evades antibodies induced by infection and vaccination," *Cell Rep.*, vol. 36, no. 3, p. 109415, 2021, doi: <https://doi.org/10.1016/j.celrep.2021.109415>.
- [2] D. N. Fisman and A. R. Tuite, "Progressive Increase in Virulence of Novel SARS-CoV-2 Variants in Ontario, Canada," *medRxiv*, p. 2021.07.05.21260050, Jan. 2021, doi: [10.1101/2021.07.05.21260050](https://doi.org/10.1101/2021.07.05.21260050).
- [3] V.-V. Edara et al., "Infection and Vaccine-Induced Neutralizing-Antibody Responses to the SARS-CoV-2 B.1.617 Variants," *N. Engl. J. Med.*, vol. 385, no. 7, pp. 664–666, Jul. 2021, doi: [10.1056/NEJMc2107799](https://doi.org/10.1056/NEJMc2107799).
- [4] P. R. Krause et al., "SARS-CoV-2 Variants and Vaccines," *N. Engl. J. Med.*, vol. 385, no. 2, pp. 179–186, Jun. 2021, doi: [10.1056/NEJMs2105280](https://doi.org/10.1056/NEJMs2105280).
- [5] J. Flint, V. R. Racaniello, G. F. Rall, and A. M. Shalka, *Principles of Virology*, 4th ed., vol. 2. American Society for Microbiology, 2015.
- [6] C. Souza, J. Bessa, R. Freitas, M. Oliveira, and K. Mota, "Estratégia Algorítmica para a Reconstrução e Validação da Estrutura Molecular de Variantes do SARS-CoV-2," in *Anais do XV Brazilian e-Science Workshop*, 2021, pp. 65–72, doi: [10.5753/bresci.2021.15790](https://doi.org/10.5753/bresci.2021.15790).
- [7] M. D. L. Oliveira, K. M. T. Oliveira, J. N. Silva, C. Santos, J. Bessa, and R. de Freitas, "Theoretical causes of the Brazilian P.1 and P.2 lineages of the SARS-CoV-2 virus through molecular dynamics," *bioRxiv*, p. 2021.04.09.439181, Jan. 2021, doi: [10.1101/2021.04.09.439181](https://doi.org/10.1101/2021.04.09.439181).
- [8] C. Souza, J. Bessa, R. Freitas, M. Oliveira, and K. Mota, "Improvement of SARS-CoV-2 macromolecule conformation by algorithmic structural prediction," in *Conference Proceedings of XLVII Latin American Computing Conference (CLEI)*, 2021.



# Submodular Optimization and the Greedy Algorithm

Alfredo Torrico <alfredo.torrico-palacios@polymtl.ca> CERC in Data Science, Polytechnique Montréal

## 1 Introduction

Submodularity has played a fundamental role in problems that lie at the intersection of computer science, operations research, economics and game theory. During the last decade, the interest in constrained submodular maximization has increased significantly, especially due to its multiple applications such as influence modeling in social networks [11], sensor placement [13], document summarization [14], or in general constrained feature selection [12]. To illustrate the submodular property, consider the problem of selecting a subset of sensor locations that maximizes the coverage of a certain area. Submodularity naturally captures the decreasing marginal gain in the coverage by using more sensors. Given the importance of submodular optimization, there has been significant progress in designing new algorithms with provable guarantees for static and dynamic settings.

In this tutorial, we mainly focus on the submodular function maximization problem subject to a single cardinality constraint, but at the end we will briefly discuss a wider class of combinatorial constraints called matroids. Formally, consider a ground set of  $n$  elements  $V = \{1, \dots, n\}$  and a non-negative set function  $f : 2^V \rightarrow \mathbb{R}_+$ . We denote the marginal value for any subset  $A \subseteq V$  and  $e \in V$  by  $f_A(e) := f(A+e) - f(A)$ , where  $A+e := A \cup \{e\}$ . A set function  $f$  is submodular if, and only if, it satisfies the diminishing returns property. Namely, for any  $e \in V$  and  $A \subseteq B \subseteq V \setminus \{e\}$ ,  $f_A(e) \geq f_B(e)$ . We say that  $f$  is monotone if for any  $A \subseteq B \subseteq V$ , we have  $f(A) \leq f(B)$ . To ease the notation, we will write the value of singletons as  $f(e) := f(\{e\})$ . For simplicity, we assume that  $f$  is normalized, i.e.,  $f(\emptyset) = 0$ . The main results in this tutorial still hold when  $f(\emptyset) \neq 0$ , but an additive extra term has to be carried over.

We study the following optimization problem: Given a non-negative integer  $k$ , the goal is to optimally select a subset  $S$  that contains at most  $k$  elements of  $V$ . Formally,

$$\max\{f(S) : |S| \leq k\}. \quad (1)$$

Henceforth, we denote the optimal value as OPT. A classical example of Problem (1) is the maximum coverage problem, e.g. see [8], known to be NP-hard. There are two technical issues that need to be clarified with respect to Problem (1). First, the non-negativity of the function is necessary for the design of approximation algorithms with multiplicative guarantees. Second, the description of the objective function  $f$  might be exponential in the number of elements  $n$ . To deal with this, it is commonly assumed that the decision-maker has access to a *value oracle*, i.e., given a subset  $S \subseteq V$ , the oracle returns its value  $f(S)$ . Therefore, the complexity of the algorithms are measured, most of the time, with respect to the number of oracle queries.

Given the hardness of Problem (1), the goal is to design an approximation algorithm, i.e., an algorithm that runs in polynomial time (oracle queries) and that outputs a feasible

set whose objective value is at least some fraction of OPT. A natural approach is the standard *greedy algorithm* which constructs a set by adding in each iteration the element with the best marginal value, while maintaining feasibility. We formally state the greedy algorithm in Algorithm 1. Nemhauser, Wolsey and Fisher [18] show the following result for Problem (1).

**Theorem 1** (Due to [18]). *The greedy algorithm runs in  $O(nk)$  time and outputs a set  $S^g$  such that  $f(S^g) \geq (1 - 1/e) \cdot \text{OPT}$ .*

The  $1 - 1/e \approx 0.632$  factor is known to be tight [17, 8]. Roughly speaking, Nemhauser and Wolsey [17] show that, without complexity assumptions, an exponential number of queries is needed to improve beyond  $1 - 1/e$ .

### Algorithm 1 Greedy [18]

**Input:** ground set  $V = \{1, \dots, n\}$ , monotone submodular function  $f : 2^V \rightarrow \mathbb{R}_+$  and  $k \in \mathbb{Z}_+$

**Output:** set  $S$  with  $|S| \leq k$ .

1: Initialize  $S = \emptyset$ .

2: **while**  $|S| < k$  **do**

3:  $S \leftarrow S + \arg\max_{e \in V \setminus S} f_S(e)$

In the following, we will briefly discuss: (1) improved guarantees for the greedy algorithm under certain conditions, (2) efficient variants of greedy and (3) the role of greedy and its continuous version when dealing with matroid constraints.

## 2 Improved Guarantees

As we mentioned in the previous section, the best possible guarantee for the general problem of maximizing a non-negative monotone submodular function subject to a single cardinality constraint is  $1 - 1/e$  [17]. However, the standard greedy algorithm usually performs better in practice. This observation has posed the following challenge: Are there specific properties in real world instances that the greedy algorithm exploits?

An attempt to explain the empirical behavior of the greedy algorithm has been made with the concept of *curvature*, which was introduced by Conforti and Cornuéjols [6]. This property measures how far the objective function is from being linear. Formally, a monotone submodular function  $f : 2^V \rightarrow \mathbb{R}_+$  has curvature  $\gamma \in [0, 1]$  if  $f_S(e) \geq (1 - \gamma)f(e)$  for every  $S \subseteq V$  and  $e \notin S$ . Note that any monotone set function satisfies this property for  $\gamma = 1$ . Also, since we are assuming that  $f$  is submodular, we know that  $f_S(e) \leq f(e)$  which means that the marginal values are upper and lower bounded by the corresponding singleton values. In fact, both bounds coincide when the function is linear:  $\gamma = 0$  if, and only if, the function is linear, i.e.,  $f(S) = \sum_{e \in S} f(e)$  for every  $S \subseteq V$ . Finally, submodularity allows us to compute the curvature as follows:

>>



$$\gamma = 1 - \min_{e \in V^*} \frac{f_{V-e}(e)}{f(e)}, \quad (2)$$

where  $V^* = \{e \in V : f(e) > 0\}$

For a monotone submodular function with curvature  $\gamma \in [0,1]$ , Conforti and Cornuéjols [6] showed that the greedy algorithm guarantees an approximation factor of  $(1 - e^{-\gamma})/\gamma$  for Problem (1). Observe that for  $\gamma = 1$ , i.e., any monotone submodular function, the  $1 - 1/e$  factor is recovered. On the other hand, for  $\gamma = 0$ , i.e., a linear objective, the greedy algorithm outputs an optimal solution.

The main issue with the curvature parameter is that it is a global metric which does not take into account the local behavior of the objective. For instance, consider  $f(S) = \min\{|S|, k\}$  for Problem (1). Observe that the greedy algorithm always finds an optimal solution, which corresponds to any subset of size exactly  $k$ . On the other hand, note that for any  $e \in V$  we have  $f_{V-e}(e) = 0$ . Therefore, Equation (2) tells us that the curvature of  $f$  is  $\gamma = 1$ , resulting in no improvement for the theoretical guarantee of the greedy algorithm, which contrasts its empirical behavior. This has recently motivated the study of other approaches such as the sharpness criteria [19], budget-smooth analysis [20] and instance-specific guarantees [3].

### 3 Improved Efficiency

The vanilla version of the greedy algorithm, Algorithm 1, performs  $O(nk)$  oracle evaluations. Even for medium-scale instances,  $n = 10^4$  or  $10^5$ , this can become computationally intractable. Therefore, the research community has also focused on variants of the greedy algorithm which are efficient and, ideally, preserve the approximation guarantees. In the following, we briefly discuss three important variants of the greedy algorithm.

Minoux [15] introduced an accelerated version of the greedy algorithm which performs *lazy evaluations*. This method keeps a list in decreasing order of upper bounds  $\rho(e)$  of the marginal gain for each element (initially  $\infty$ ). At each iteration, the greedy algorithm can evaluate the element at the top of the list, say  $e'$ . If its marginal gain satisfies  $f_S(e') \geq \rho(e)$  for all  $e \neq e'$ , where  $S$  is the set being constructed by greedy, then submodularity ensures  $f_S(e) \geq f_S(e')$ . In this way, the greedy algorithm does not need to evaluate all of the marginal values at every iteration to select the best element. This method significantly improves the performance of greedy in practice, however, an upper bound for the number of oracle queries that it performs is unknown.

Badanidiyuru and Vondrák [2] introduced the threshold greedy algorithm. Roughly speaking, this method iteratively adds elements whose marginal value is above certain threshold, determined by a parameter  $\delta > 0$ , while maintaining feasibility. Unlike Algorithm 1, threshold greedy may add more than one element in a single iteration. For cardinality constraint, Badanidiyuru and Vondrák [2] showed that the threshold greedy algorithm performs  $O(\frac{n}{\delta} \cdot \log \frac{n}{\delta})$  oracle queries and achieves a  $(1 - 1/e - \delta)$ -approximation factor. The main advantage of this method is that its number of oracle queries does not depend on the cardinality budget  $k$ , which is crucial for large-scale instances.

Finally, Mirzasoleiman et al. [16] proposed the *stochastic greedy*

algorithm. At each iteration, this method constructs a random subset  $R$  of  $V \setminus S$  by independently sampling  $(n/k) \log(1/\delta)$  elements, where  $S$  is the current set being constructed. Then, it selects the element in  $R$  with the best marginal value and repeats. For cardinality constraint, Mirzasoleiman et al. [16] proved that the stochastic greedy algorithm performs  $O(n \cdot \log \frac{1}{\delta})$  queries and achieves, in expectation, a  $(1 - 1/e - \delta)$ -approximation factor. Note the number of oracle queries also does not depend on  $k$  and is strictly better than the threshold greedy.

### 4 Matroid Constraints

A natural class of constraints considered in submodular optimization are *matroid* constraints.

For a ground set  $V$  and a family of sets  $\mathcal{I} \subseteq 2^V$ ,  $\mathcal{M} = (V, \mathcal{I})$  is a matroid if (1) for all  $A \subset B \subseteq V$  if  $B \in \mathcal{I}$  then  $A \in \mathcal{I}$  and (2) for all  $A, B \in \mathcal{I}$  with  $|A| < |B|$ , there is  $e \in B \setminus A$  such that  $A \cup \{e\} \in \mathcal{I}$ . Sets in such a family  $\mathcal{I}$  are called *independent* sets. A common example of a matroid is the partition matroid: let us assume that  $V$  is partitioned in  $q$  sets  $P_1, \dots, P_q$ , then given budgets  $k_j \in \mathbb{Z}_+$  for all  $j \in [q]$ , the family of independent sets is  $\mathcal{I} = \{S \subseteq V : |S \cap P_j| \leq k_j, \forall j \in [q]\}$

The classical problem of maximizing a single monotone submodular function  $f : 2^V \rightarrow \mathbb{R}_+$  under a matroid constraint  $\mathcal{M} = (V, \mathcal{I})$  is formally stated as:  $\max_{S \in \mathcal{I}} f(S)$ . Fisher, Nemhauser and Wolsey [10] showed that the standard greedy algorithm achieves a  $1/2$ -approximation. Notably, Vondrák [21] introduced the *discretized continuous greedy* algorithm that achieves a tight  $1 - 1/e$  approximate solution. To describe this algorithm, we need to define the multilinear extension of a set function. Consider any non-negative set function  $f : 2^V \rightarrow \mathbb{R}_+$ , its multilinear extension  $F : [0,1]^V \rightarrow \mathbb{R}_+$  is defined for any  $y \in [0,1]^V$  as the expected value of  $f(S_y)$ , where  $S_y$  is the random set generated by drawing independently each element  $e \in V$  with probability  $y_e$ . Formally,

$$F(y) = \mathbb{E}_{S \sim y}[f(S)] = \sum_{S \subseteq V} f(S) \prod_{e \in S} y_e \prod_{e \notin S} (1 - y_e). \quad (3)$$


Observe, this is in fact an extension of  $f$ , since for any subset  $S \subseteq V$ , we have  $f(S) = F(\mathbf{1}_S)$ , where  $\mathbf{1}_S \in \{0,1\}^V$  is the indicator vector of  $S$ , i.e.,  $\mathbf{1}_S(e) = 1$  if  $e \in S$  and zero otherwise. For more properties of the multilinear extension, we refer the interested reader to [5].

At a high level, the discretized continuous greedy works as follows: The algorithm discretizes the interval  $[0,1]$  into points  $\{0, \delta, 2\delta, \dots, 1\}$  for a given  $\delta > 0$ . Starting at  $y_0 = 0$ , for each  $\tau \in \{\delta, 2\delta, \dots, 1\}$  the algorithm obtains *direction*  $z_\tau = \arg\max_{z \in \mathcal{P}(\mathcal{I})} \langle \nabla F(y_{\tau-\delta}), z \rangle$ , where  $\mathcal{P}(\mathcal{I}) = \text{conv}\{\mathbf{1}_S \mid S \in \mathcal{I}\}$ . Then, the algorithm takes a step in the direction of  $z_\tau$  by setting  $y_{\tau,e} \leftarrow y_{\tau-\delta,e} + \delta z_{\tau,e}$  for all  $e \in V$ . Basically, at each iteration, the algorithm is greedily adding a fraction of different elements to the solution, where these elements are determined by the direction  $z_\tau$  that maximizes the “continuous marginal values”  $\nabla F(y_{\tau-\delta})$ . Finally, by appropriately rounding the fractional solution  $y_1$ , the algorithm outputs a feasible  $S^g \in \mathcal{I}$  set that satisfies  $f(S^g) \geq (1 - 1/e) \cdot \max_{A \in \mathcal{I}} f(A)$ .

## 5 Further Comments

As we discussed in the previous sections, the role of the greedy algorithm in submodular maximization has been crucial over the last 40 years to provide both efficiency and quality guarantees. The increasing interest from the machine learning and artificial intelligence communities has further motivated the design of new efficient variants of greedy and the study of related submodular optimization models. For instance, greedy algorithms have been used for non-monotone submodular maximization [9] and non-submodular settings [7]. Finally, exciting progress has been made towards dealing with large-scale instances such as parallelization [4] and streaming models [1].

## References

- [1] Ashwinkumar Badanidiyuru, Baharan Mirzasoleiman, Amin Karbasi, and Andreas Krause. Streaming submodular maximization: Massive data summarization on the fly. In *Proceedings of the 20th ACM SIGKDD international conference on Knowledge discovery and data mining*, pages 671–680, 2014.
- [2] Ashwinkumar Badanidiyuru and Jan Vondrák. Fast algorithms for maximizing submodular functions. In *Proceedings of the Twenty-Fifth Annual ACM-SIAM Symposium on Discrete Algorithms*, pages 1497–1514, 2014.
- [3] Eric Balkanski, Sharon Qian, and Yaron Singer. Instance specific approximations for submodular maximization. *arXiv preprint arXiv:2102.11911*, 2021.
- [4] Eric Balkanski, Aviad Rubinstein, and Yaron Singer. An exponential speedup in parallel running time for submodular maximization without loss in approximation. In *Proceedings of the Thirtieth Annual ACM-SIAM Symposium on Discrete Algorithms*, pages 283–302. SIAM, 2019.
- [5] Grigori Calinescu, Chandra Chekuri, Martin Pál, and Jan Vondrák. Maximizing a monotone submodular function subject to a matroid constraint. *SIAM Journal on Computing*, 40(6):1740–1766, 2011.
- [6] Michele Conforti and Gérard Cornuéjols. Submodular set functions, matroids and the greedy algorithm: Tight worst-case bounds and some generalizations of the radoedmonds theorem. *Discrete Applied Mathematics*, 7(3):251–274, 1984.
- [7] Abhimanyu Das and David Kempe. Submodular meets spectral: Greedy algorithms for subset selection, sparse approximation and dictionary selection. In *Proceedings of the 28th International Conference on International Conference on Machine Learning, ICML’11*, page 1057–1064, Madison, WI, USA, 2011. Omnipress.
- [8] Uriel Feige. A threshold of  $\ln n$  for approximating set cover. *Journal of the ACM (JACM)*, 45(4):634–652, 1998.
- [9] Moran Feldman, Joseph Naor, and Roy Schwartz. A unified continuous greedy algorithm for submodular maximization. In *Proceedings of the 52nd Annual Symposium on Foundations of Computer Science (FOCS)*, pages 570–579, 2011.
- [10] Marshall L. Fisher, George L. Nemhauser, and Laurence A. Wolsey. An analysis of approximations for maximizing submodular set functions–II. In *Polyhedral combinatorics*, pages 73–87. Springer, 1978.
- [11] David Kempe, Jon Kleinberg, and Éva Tardos. Maximizing the spread of influence through a social network. *Theory of Computing*, 11(4):105–147, 2003.
- [12] Andreas Krause and Carlos Guestrin. Near-optimal non-myopic value of information in graphical models. In *Proceedings of the 21st Conference on Uncertainty in Artificial Intelligence (UAI)*, pages 324–331, 2005.
- [13] Andreas Krause, H. Brendan McMahan, Carlos Guestrin, and Anupam Gupta. Robust submodular observation selection. *Journal of Machine Learning Research*, 9:2761–2801, 2008.
- [14] Hui Lin and Jeff A. Bilmes. How to select a good training-data subset for transcription: submodular active selection for sequences. In *Proceedings of the 10th Annual Conference of the International Speech Communication Association (INTERSPEECH)*, pages 2859–2862, 2009.
- [15] M. Minoux. Accelerated greedy algorithms for maximizing submodular set functions. *Optimization Techniques, LNCS*, pages 234–243, 1978.
- [16] Baharan Mirzasoleiman, Ashwinkumar Badanidiyuru, Amin Karbasi, Jan Vondrák, and Andreas Krause. Lazier than lazy greedy. In *Proceedings of the 29th AAAI Conference on Artificial Intelligence (AAAI)*, pages 1812–1818, 2015.
- [17] George L. Nemhauser and Laurence A. Wolsey. Best algorithms for approximating the maximum of a submodular set function. *Mathematics of Operations Research*, 3(3):177–188, 1978.
- [18] George L. Nemhauser, Laurence A. Wolsey, and Marshall L. Fisher. An analysis of approximations for maximizing submodular set functions–I. *Mathematical Programming*, 14(1):265–294, 1978.
- [19] Sebastian Pokutta, Mohit Singh, and Alfredo Torrico. On the unreasonable effectiveness of the greedy algorithm: Greedy adapts to sharpness. In Hal Daumé III and Aarti Singh, editors, *Proceedings of the 37th International Conference on Machine Learning*, volume 119 of *Proceedings of Machine Learning Research*, pages 7772–7782. PMLR, 13–18 Jul 2020.
- [20] Aviad Rubinstein and Junyao Zhao. Budget-smoothed analysis for submodular maximization. *arXiv preprint arXiv:2102.05782*, 2021.
- [21] Jan Vondrák. Optimal approximation for the submodular welfare problem in the value oracle model. In *Proceedings of the 40th Annual ACM Symposium on the Theory of Computing (STOC)*, pages 67–74, 2008. 



# Promoting OR's Global Success in Solving Real Problems: Examples Over the Last Decade

## Introduction

In 2012 John Ranyard and Sue Merchant, both retired OR group managers, conceived the idea of a regular column devoted to OR studies (from all IFORS regions) that had made a significant impact on the client organisation. We were aware that OR is based in Universities in many parts of the world and that to survive, researchers need to publish in peer reviewed journals. However, very few papers are published about impactful implemented work since journal editors are mainly interested in publishing details about new methods that have the potential to achieve significant benefits. They are less interested in following through to the actual impact in the real world. Also many practitioners of OR don't need to publish their work in order to further their careers so contribute very few papers on implemented studies.

## Sources of articles –

Our main sources are the various competitions and awards which focus on the impact of OR. These include the IFORS Prize for Development, the INFORMS Edelman Award, and its Wagner prize for OR Practice, the UK President's Medal for the best implemented OR and the EURO Excellence in Practice Award. All of these annual awards attract entries from around the world. In addition OR/MS Today (INFORMS) and Impact magazine (UK OR Society) contain articles promoting the success of OR practice, which, with permission, can be refocused to our template and included in our column. However, despite this apparent wealth of material relevant to our column, there is a bias towards OR in developed countries which we strive to overcome as far as possible.

## Request to readers!

If you are aware of any projects that meet our criteria, particularly in the less well represented regions (see below), please let us know.

## Published Articles

The column started in September 2012 and as of September 2021 we have published 38 articles, including: 20 from EURO\*; 8 from APORS and NORAM\*; and 6 from ALIO (\*EURO and INFORMS have 4 articles with authors from both regions ).

**Application areas** cover most industrial sectors, including Health (a particularly fertile area for OR), Transport/Distribution, Marketing and Manufacturing. **Methods Used** are dominated by optimisation, particularly MIP, often supported by novel heuristics, and simulation, with solutions often embedded in user friendly Decision Support

Systems. Several Analytics/Big Data articles have been

published, reflecting the growing influence of OR in this area, plus one or two based on Soft OR, which is largely confined to the UK.

## Some highlights

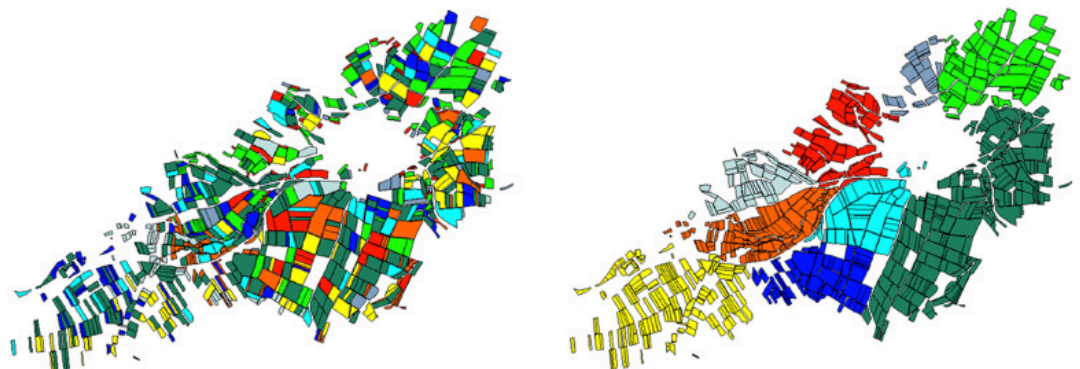
Some examples are given here to highlight particularly impactful studies, techniques used, regions covered and in some cases, application areas that are relatively new to OR. For many years South Africa was the only African nation belonging to IFORS and for this reason it was grouped with EURO. More recently AFROS (the African regional OR society) has become established, with Nigeria and Tunisia joining South Africa. The only African article we have been able to include to date is the excellent "Optimising HIV Testing in South Africa" by Stephen Stafford, Shout-it-Now, South Africa (June 2016 issue).

## Improving Farmers' Efficiency by Optimising Land Clustering

Andreas Brieden, Universität der Bundeswehr München, Dec 2013, EURO.

This study dealt with the problem of the inefficiency of small areas of agricultural land in Germany. Farmers own small plots of land scattered across a wide area: e.g. in Figure 1 here one farmer owns all the yellow square fields shown, another all the green ones and so on. As a result farmers had to move machinery from field to field, which wasted much time. The analysts used OR methods to develop efficient algorithms, taking less than 30 seconds on a laptop, which moved the Centre of Gravity of the colour clusters as far apart as possible; this is known as "partitioning a finite weighted point set in Minkowski space".

Visualisation tools & economic evaluations were produced showing options for farmers, who were involved heavily in the discussions of the improved methods, which have proved to be very successful and are still in use today.



▲ Fig. 1 Before and after Land Clustering in Germany



## Improving Shelter Planning following Natural Disasters in the Philippines

Sarah Redoblado, Alterplan Community Support and Leorey Marquez CSIRO, Australia, September 2014, APORS

The Philippines has always been subject to many natural disasters from flooding to earthquakes, mud slides, drought and volcanic eruptions. As a result: poor and vulnerable populations are more exposed to the impact of disasters and struggle to recover from them. They often can't get insurance or loans and have few resources or social support services. Seventy one million individuals were affected between 2000-2012 and some 375,000 people were made homeless.

A community driven development project was therefore set up to mitigate disaster risk and increase sustainability in 10 small regions of the country. Data collection was undertaken, involving a variety of local people and organisations, together with OR experts, who used a range of OR and Statistical methods to analyse/display the data and compare options – a great example of group decision making in action.



▲ Fig. 2 Group Decision Making in the Philippines

### Optimising Ambulance Efficiency in São Paulo

Luiz Augusto C. G. de Andrade and Claudio B. da Cunha, University of São Paulo, Brazil (IFORS Prize for OR in Development in 2014) March 2016 ALIO. In 2007 the emergency response time for ambulances in Sao Paolo was 27 mins for 98% of requests, whereas, for comparison, the US legal requirement was a 95% response in less than 10 minutes.

An improvement initiative commenced in 2009 covering 140 ambulances based at 77 fixed stations. Sites for stations in busy cities are hard to find so *movable* stations were also considered. Two key questions needed to be answered; how many movable stations were needed; and where should movable, fixed stations and ambulances be based to minimise response times.

The University team worked with the emergency ambulance service (SAMU) officials to improve response times. A number of approaches were tried including the **Artificial Bee Colony** algorithm (a particular class of swarm-based meta-heuristics), which SAMU officials found to be more appealing than other approaches and it was also intuitive to use.

The problem was split into 2 sub-problems: locating stations and allocating vehicles across a planning horizon (solved

using the ABC method); and relocating vehicles to a more effective location in different time periods (solved using a transportation simplex method).

The outcome was that the average response time was cut from 27 mins to 10 minutes, and that SAMU became the first Latin American ambulance service to be recognised as an Accredited Centre of Excellence.



▲ Fig. 3 An Ambulance Station in Sao Paulo

### Placement Optimization in Refugee Resettlement

Andrew C. Trapp, Worcester Polytechnic Institute, Worcester, MA USA et al, June 2019, NORAM.

In 2017 there were 1.2 million refugees under the mandate of the UN High Commission for Refugees needing resettlement to a third country, such as the USA. An optimal match between each refugee family and their new community is crucial for social, economic & humanitarian reasons. However, matching refugees with placements in 2017 at one US agency was largely done by hand and was very time-consuming.

A multi-national team came together to design an interactive decision support system, Annie™, incorporating integer optimisation and machine learning, to improve the outcome of matching refugees to available placements. Factors included: family characteristics (language, nationality, number of children etc.) and the availability of housing, English language classes, school places and the likely fit of families to available locations.

A few key details of the system and model which helped in making it successful included:

- Managers and resettlement staff were involved from the very beginning.
- The employment outcome of a match is of specific interest in this study- the value of each refugee-location match is called the quality score
- An integer optimisation problem that maximises an objective function (e.g. expected number of employed refugees) over all matched refugees was formulated and tested.
- The LASSO approach (least absolute shrinkage and selection operator), added to the interacted logit constraint, proved to be the better approach and was incorporated into Annie™.



The outcome included:

The first version of Annie™ was delivered to the Hebrew Immigrant Aid Society in May 2018 and presented to US State Dept. and HIAS staff in August 2018. The model was updated regularly and given new features. Annie™ augments the resettlement work of staff: who have discretion to use their expert judgement and local knowledge.

Staff report that the allocation process improved from around half a day to around 1 hour and time was freed up for more complex cases involving medical conditions etc.

The model was predicted to improve refugee employment prospects by up to 37%.

**Improving the Efficiency of a Large Bio-manufacturing Hub,**  
Tugce Martagan, Technical University of Eindhoven and Bram van Ravenstein, MSD AH, Netherlands, March 2020, EURO

The bio-manufacturing industry is growing rapidly and is projected to reach \$388 billion by 2024 but until recently has received little attention from OR, despite the potential for significant improvements. An inter-disciplinary team of researchers from Merck Sharp and Dohme Animal Health (MSD AH) and Eindhoven University of Technology (TU/e) has been collaborating for almost four years to develop a portfolio of optimization models and decision support tools, which have resulted in an additional revenue of €50m.

Recent advances in bio-manufacturing have made it possible to re-engineer living organisms, such as viruses and bacteria, and use them in the pharmaceutical drug manufacturing processes to generate active ingredients. The resulting active ingredients are highly complex and innovative compared to conventional drugs and are known as 'next-generation drugs' and are very effective.

Three projects, which have made a major impact on the efficiency of operations at the huge Boxmeer facility are described in the article, including **Achieving a Higher Batch Yield** at a fermentation production line.



▲ Fig. 5 A Bio-Manufacturing Plant at Boxmeer

The main bioreactor in this new production line was consistently producing a lower yield (amount of active ingredient) compared to other production lines. Further investigation showed that a critical process parameter needed to be optimised. The team developed a decision support tool using the theory of Bayesian design of experiments, which enabled an effective information collection policy

through real-world experiments and identified an optimum configuration for the bioreactor. The resulting configuration has been implemented at MSD AH for almost two years and has led to a 50% higher yield per batch.

**Optimising and Automating Road Design,**

Prof Yves Lucet, University of British Columbia, Canada June 2020 NORAM

In the 2015/2016 fiscal year, Canada territorial, provincial and federal agencies spent 15.9 billion dollars to build and extend roads. Reducing the cost of road construction, without compromising safety, holds the potential for savings in the millions of dollars. In 2009, Softree Technical Systems (a software development company that commercialises road-design engineering tools) began a long-term collaboration with the University of British Columbia (UBC) to research automated road design and optimization.

Road design consists in selecting an alignment that connects two given points. The objective is to minimize costs while satisfying safety, building code, and environmental constraints.



▲ Fig. 4 Visualisation of a Road Design Alignment

The aim is to compute an optimal solution in reasonable time, which is easier today because of improvements in modelling, the availability of efficient optimization solvers, access to accurate survey information and improved computing speed. The outcome is the commercial software, Softree Optimal, that incorporates several innovations, including the use of bi-level programming. One application is in Franklin County (Washington, USA) to support the redesign of a road to accommodate higher speeds. The horizontal alignment was to remain straight with a focus on modifying the vertical alignment. The Softree Optimal software enabled an alignment similar to a manually designed one but was 23% cheaper. Moreover, the volume of material excavated and filled was also significantly lower, reducing the environmental impact of the project.

## Reflections

Our articles demonstrate that OR is making a significant impact on the efficiency/effectiveness of client organisations and that many research developments eventually lead to significant impacts in the real world. We believe that these articles can help to promote the use of OR and we hope to put them together in one place on the IFORS website, together with an index for ease of access. 🌍





# Data Science meets Optimization - Workshop at IJCAI 2021 in Montreal, Canada

**Patrick De Causmaecker** <patrick.decausmaecker@kuleuven.be>

This workshop was the fourth of its kind in a list of twelve activities organized by *EWG/DSO* since its foundation in 2016. The *IJCAI* organizing committee has warmly welcomed us this year as they did in the previous years, and the organizers of the *Montreal* edition did a great job setting up a fully *online* conference. *Life* attendance was ample with around 50 participants. We had lively and inspiring conversations on the *virtual* gather town site offered by the organizers of the conference. All material is available at <https://sites.google.com/view/ijcai2021dso/program>.

such as *CEC 2017*, *CPAIOR 2017*, *IFORS (2017, 2020)*, *EURO (2018, 2019, 2021)*, *IJCAI (2018, 2019, 2020)* and *IJCAI 2021*.

The aim of the workshop at *IJCAI 2021*, August 19-20, 2021, was to organize an open discussion and exchange of ideas by researchers from Data Science, Constraint Optimization and *Operational Research* in order to identify how techniques from these fields can benefit each other. The Program Committee invited submissions on the following topics:

- Applying data science and machine learning methods to solve combinatorial optimization problems, such as algorithm selection based on historical data, speeding up (or driving) the search process using Machine Learning including reinforcement learning, and handling uncertainties of prediction models for decision-making or neural combinatorial optimization.
- Using optimization algorithms for the development of Machine Learning models: formulating the problem of learning predictive models as MIP, constraint programming (CP), or satisfiability (SAT). Tuning Machine Learning models using search algorithms and meta-heuristics. Learning constraint models from empirical data.
- Embedding/encoding methods: combining Machine Learning with combinatorial optimization, model transformations and solver selection, reasoning over Machine Learning models. Introducing constraints in (hybrid) Machine Learning models as well as 'predict and optimize'.
- Selected contributors have been invited to submit extended articles to a special issue of *Annals of Mathematics* and *Artificial Intelligence*.

*Data Science meets Optimization* is one of the 33 working groups of *EURO*, the Association of European Operational Research Societies. >>



▲ Keynote speakers at *IJCAI 2021* were Paul Grigas, University of California, Berkeley, USA, and Patrick Henne, CTO at ORTEC, The Netherlands.

The *Data Science meets Optimization EURO Working Group* aims to study the interaction of *data science (DS)* and *optimization (O)*, and better exploitation of the areas in which they overlap. By '*optimization techniques*' we intend a broad interpretation that includes the wide range from exact methods (branch and bound mathematical programming, etc.) to heuristics and metaheuristics, and others. Data Science is also meant to cover a broad range of research domains and techniques from mathematical programming and statistical analysis to machine learning in all its diversity. Of particular interest are the two natural directions: '*Usage of DS for O*' and '*Usage of O for DS*'. The ambition of realizing strong bridges was thought to be best supported by organizing events at top level conferences linked to the various domains, rather than starting an own line of meeting events. The working group has organized successful events and streams at conferences



▲ Chairs of the workshop at *IJCAI 2021* were Yingqian Zhang (TU Eindhoven, NL), Michele Lombardi (University of Bologna, IT), Tias Guns (Vrije Universiteit Brussel, KU Leuven, BE) and Patrick De Causmaecker (KU Leuven, BE).



▲ Keynote speakers at earlier editions were *Andrea Lodi* and *Kristian Kersting* (CEC and CPAIOR 2017), *Luc De Raedt* and *Kate Smith-Miles* (IJCAI 2018), and *Holger Hoos* (IJCAI 2019).

>> In the talks and keynotes at the various workshops and streams of the working group show how the interaction between the two domains can lead to stronger and more complete solutions for the problems of today. Today's high level understanding models and algorithms for various problems in operational research is brought together with far advanced techniques in machine learning and data science. Without going into detailed examples - the websites of the streams and workshops have many to show - this can be seen to result are stronger solvers for problems on the two sides.

State-of-the-art optimization algorithms are successfully used in machine learning and data mining algorithms. Models for problems in *operational research* are generated through state-of-the-art techniques from data science. Discovering trends in evolution of data allow to predict contexts for which planning can be optimized. Optimization algorithms embed machine learning techniques to learn about the problem while solving it. Instance space analysis provides consistent views of where hard and easy problem instances are to be expected. Automated algorithm construction, configuration and tuning cannot work without strong techniques from data science. At the same time all these transfer exercises put new challenges to the original domains and strengthen cross fertilization. An example is mathematical optimization, on which an interesting series of talks can be found in the Machine Learning NeEDS

Mathematical Optimization series.

The working group is managed by Executive Committee members *Patrick De Causmaecker* (Universiteit KU Leuven, Belgium), *Ender Özcan* (University of Nottingham, UK), *Andrew J. Parkes* (University of Nottingham, UK), *Vanessa Guerrero Lozano* (Universidad Carlos III, Madrid, Spain), *Yingqian Zhang* (Technische Universiteit Eindhoven, Netherlands) and Board Members *Edmund Burke* (University of Leicester, UK), *Holger Hoos* (Universiteit Leiden, The Netherlands), *Jin-Kao Hao* (Université d'Angers, Institut Universitaire de France, France), *Andrea Lodi* (Polytechnique Montréal, Canada), *Marco Lübbecke* (RWTH Aachen Universität, Germany), *Michela Milano* (Universita di Bologna, Italy), *Barry O'Sullivan* (University College Cork, Ireland), *Kate Smith-Miles* (University of Melbourne, Australia), *Thomas Stützle* (Université Libre de Bruxelles, Belgium), *Kevin Tierney* (Universität Bielefeld, Germany), and *Mike Trick* (Carnegie Mellon University, USA).

We all thank the 150+ valued members of the working group for their continuing efforts in organizing events, participating in collaborations, contributing, taking part in discussions and for spreading the message. We are impressed to see the ever-growing scientific quality output on the interdisciplinary activity the EWG/DSO is happy to be part of. 🌍

## Enjoying Operational Research and Stochastic Mathematics in Athens - and Online: 18th Summer School in Risk Finance and Stochastics

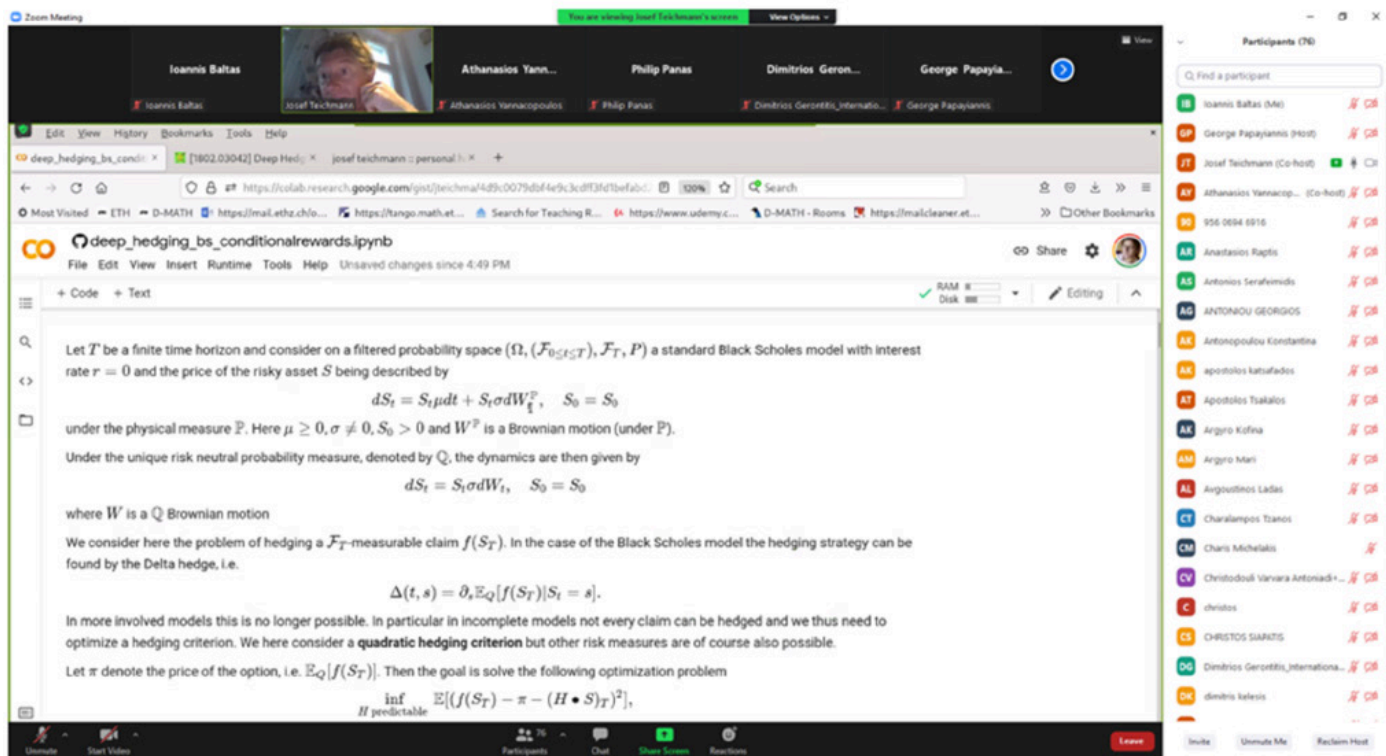
**Ioannis Baltas** <jmpaltas@aegean.gr>; **Georgios Kouretas** <kouretas@aueb.gr>;  
**Georgios Papayiannis** <gpapagiannis@aueb.gr>; **Andrianos Tsekrekos** <tsekrekos@aueb.gr>;  
**Stelios Xanthopoulos** <xanthos@aegean.gr>; **Athanasios Yannacopoulos** <ayannaco@aueb.gr>

The 18th e-Summer School in Risk Finance and Stochastics, Athens, Greece, September 6-8, 2021, was organized by the Athens University of Economics and Business (AUEB), Departments of (a) Statistics, (b) Accounting & Finance, (c) Business Administration, and the Laboratory of Stochastic Modeling and Applications (Department of Statistics, AUEB) (cf. <https://www.dept.aueb.gr/en/stat/content/department-statistics>), in collaboration with the University of the Aegean, Departments of (a) Financial & Management Engineering, and (b) Statistics & Actuarial-Financial Mathematics.

The Summer School on Risk Finance and Stochastics is an annual academic gathering that started in 2003 on Samos island, as an attempt to bring together students and academics both young and senior to present, reflect and discuss - in a

relaxed environment - certain aspects of the fascinating field of Stochastic Mathematics and its close connection with Risk, Finance and Insurance. Over the years the location of the school was moved to various places, depending on funding and circumstances, however, our rendezvous was always punctual and anticipated by all. For several years, the school was hosted on Samos Island, then on Chios Island, then Naples and, of course, Athens. Regardless of the location, we always had the honor of having with us world-class academics and experts who masterfully guided the participants through the elegant and important constructions of their current research and brilliant and eager to teach young researchers and students in the first steps of their career, the interplay among which always resulted in a creative and friendly atmosphere that we fondly remember.



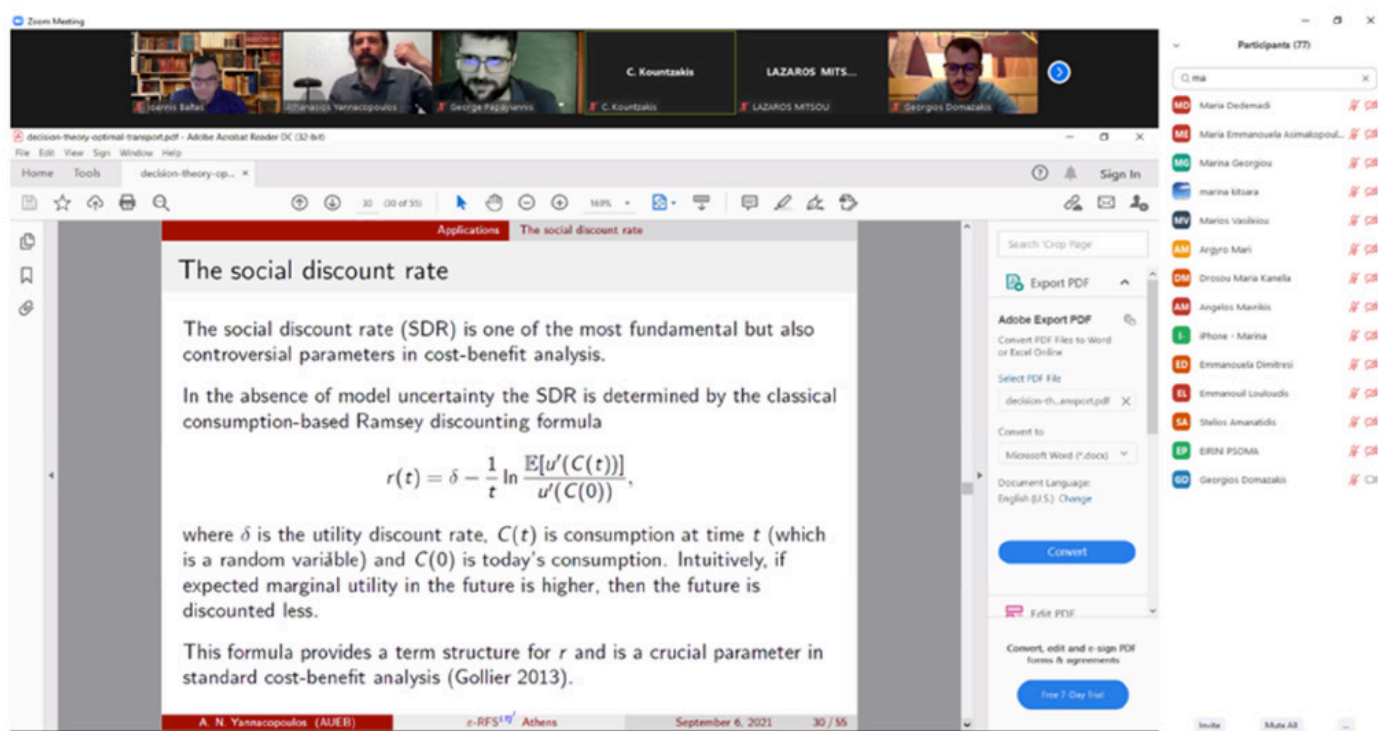


▲ A snapshot of the 18th e-summer school (lecture by Prof. Joseph Teichmann).

Naturally, this would not be possible without the constant and generous funding of AUEB and the University of the Aegean. Even though the school is mainly addressed to postgraduate students, PhD students, postdocs, researchers, and practitioners, everyone who are interested to stay informed about the latest developments in the field of Stochastic Finance, are always more than welcome to participate. This year, due to the current situation concerning the COVID-19 pandemic, the standard operation of the Summer School would have been difficult, if not impossible. However, trying to stay loyal to our usual annual meeting, we decided to transform the school into e-mode, thus enabling distant participation.

us distinguished academics in the field presenting topics. This year, the school was focused, on four areas, each one represented by illustrious *Keynote Speakers* (a) *Decision Theory* by Professor Massimo Marinacci (Universita Bocconi, Milano), (b) *Corporate Finance* by Professor Grzegorz Pawlina (Lancaster University), (c) *Machine Learning in Finance* by Professor Joseph Teichmann (ETH Zurich), and (d) *Stochastic and Optimal Control* by Professor Gerhard-Wilhelm Weber (Poznan University of Technology, Poznan). Further topics that were presented and discussed include *stochastic finance*, *portfolio theory*, *risk management* and *decision making* under uncertainty - always having in mind real-world applications and challenges as well as connections with market applications.

As always, we had the pleasure and honor of having with




▲ A snapshot of the 18th e-summer school (lecture by Prof. Athanasios Yannacopoulos).



The highlights of the e-summer school included talks by Prof. Massimo Marinacci (Department of Decision Sciences, Università Bocconi, Milano): “Models and decisions”, Prof. Athanasios Yannacopoulos (Department of Statistics, Athens University of Economics and Business, Greece): “Decision theory and optimal transport”, Prof. Grzegorz Pawlina (Department of Accounting and Finance, Lancaster University, UK): “Continuous-time corporate finance and expected equity games”, Prof. Joseph Teichmann (Department of Mathematics, ETH, Zurich): “Universal approximation on path spaces and machine learning in finance”, Prof. Dr. Gerhard-Wilhelm Weber (Faculty of Engineering Management, Poznan University of Technology, Poland, and IAM, METU, Ankara, Turkey): “Maximum principle for stochastic optimal control of a Markov regime switching jump diffusion model with delay and an extension to games”, Assoc. Prof. Benoît Chevalier-Roignant (Emlyon Business School, Lyon, France): “A model for wind farm management with option interactions”, Asst. Prof. Ioannis Baltas (Department of Financial and Management Engineering, University of the Aegean, Chios, Greece): “Robust control and applications in finance and insurance”, Dr. Konstantinos Kaloudis (Department

of Statistics, Actuarial and Financial Mathematics, University of the Aegean, Samos, Greece): “Random dynamical systems: a Bayesian approach”, Dr. Christos Merkatas (Department of Electrical Engineering and Automation, Aalto University, Finland): “Bayesian nonparametric estimation of random dynamical systems”, and Mr. Ferdinantos Kottas (Department of Economics, Accounting & Finance, Maynooth University, Ireland).

The *e-Summer School* was very well attended with more than 100 participants who showed their interest and actively participated in a lively round-table discussion in the form of oral questions. During the breaks, new friendships were made, and research ideas were exchanged between the participants, who enjoyed the warm and welcoming atmosphere of the school and expressed their interest in continuing the discussion in our future events and endeavors.

Further details on the *e-summer school* are available on the official school’s website: <http://www2.stat-athens.aueb.gr/~SummerSchool/index.html>. 

## EURO Working Group on Cutting and Packing - 17th ESICUP Meeting, Online

**Julia Bennel** <J.Bennel@leeds.ac.uk>; **José Fernando Oliveira** <jfo@fe.up.pt>



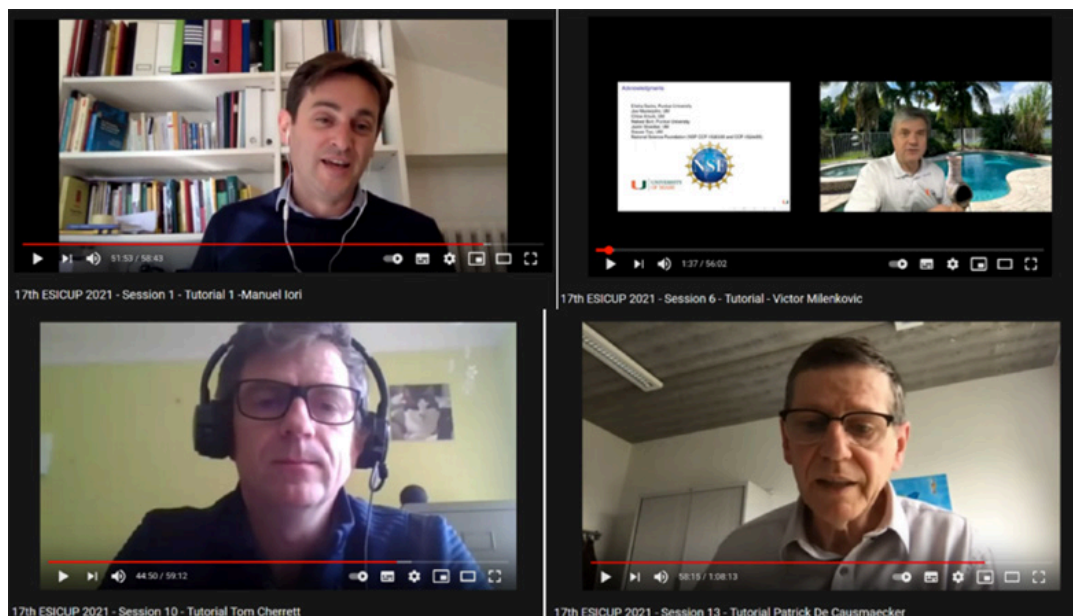
▲ 17th ESICUP Meeting, March 22-26, 2021, online.

The *European Working Group on Cutting and Packing – ESICUP* (<https://www.euro-online.org/websites/esicup/>) has a long history predating its establishment as an *EWG* in 2003. Since then the group has consistently organised an annual workshop. Unfortunately, in 2020, like most academic conferences, the meeting scheduled for the lovely city of Toledo, Spain, was cancelled. Faced with similar challenges in 2021, we decided that the 17th *ESICUP* meeting would be held *Online* in 2021 (<https://www.euro-online.org/websites/esicup/17th-esicup-meeting/>). While we all missed the social and intellectual interactions during the usual coffee breaks and meals, the meeting still provided a forum for those working in the *Cutting*

and *Packing* field to share and discuss their research.

*ESICUP* gathers practitioners, researchers and *Operational Research* educators with interests in the area of *Cutting and Packing*. The purpose of *ESICUP* is to improve communication and collaboration among individuals working in this field. While *ESICUP* is a European group, we have been keen to engage globally with the cutting and packing research community. Most meetings have been held in Europe, however we have also held meetings in Tokyo, Argentina, China and Mexico. The 2019 meeting in Mexico City included 14 different nationalities spanning four continents.

This year, the meeting was organised around a set of tutorials, as well as the contributed sessions, but without parallel sessions. The scientific program was scheduled over a whole week, March 22-26, 2021, but running only from 13:00 pm (GMT) to 16:30 pm (GMT). A shorter day was intended to reduce screen fatigue and the timing was intended to make the meeting accessible to as many countries across the globe as possible. In the meeting, contributions dealing with all aspects of the Cutting and Packing problems formulation, resolution or application were presented. This included theoretical achievements, algorithms development and real-world implementations. Among other problems, the talks covered One-Dimensional Problems, Two-Dimensional



▲ A snapshot of the tutorials' speakers (from left to right and top-down): Manuel Iori, Victor Milenkovic, Tom Cherrett, and Patrick de Causmaecker.

With 57 registered participants, from 16 different countries, from Australia, China and Japan to Brazil (the largest group) and Canada:

Country	Number of Participants
Brazil	11
Belgium	6
Spain	6
Portugal	5
Germany	5
United Kingdom	4
Unknown	4
France	3
Italy	2

Country	Number of Participants
Sweden	2
Australia	2
Canada	2
China	1
Japan	1
Ukraine	1
South Africa	1
Switzerland	1

Rectangular Problems, Nesting and Irregular Shapes Packing, Three-Dimensional Packing, Bin-Packing, Container Loading, both as stand-alone problems and integrated with other relevant and hard production and logistics related problems. The tutorials were very successful, of high quality and with a lot of participation:

- "Combinatorial Benders decompositions for two-dimensional packing problems", Manuel Iori, University of Modena and Reggio Emilia (Italy),
- "ACP: A Library for Robust Geometric Computation", Victor Milenkovic, University of Miami (USA),
- "The packing and optimisation challenges of switching to portering/cycle couriering for last-mile B2C parcel delivery", Tom Cherrett, University of Southampton (United Kingdom),
- "Data science meets optimization, is one to help the other?", Patrick De Causmaecker, University of Leuven (Belgium).

Both the tutorials and the contributed sessions are available in YouTube:

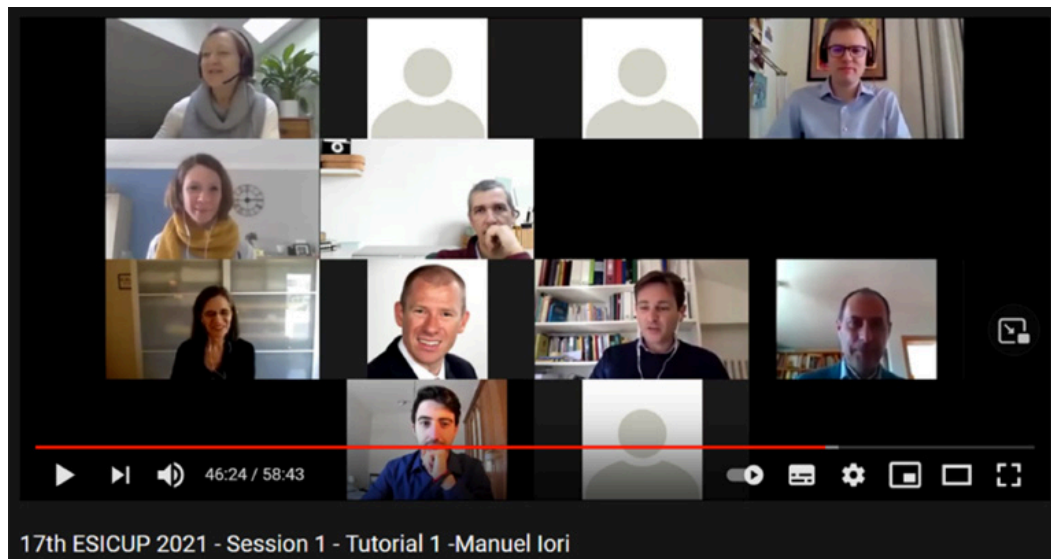
<https://www.youtube.com/channel/UCDBD91xp662T32qWq3PXEqQ>

the meeting ran very well, and, on behalf of *ESICUP* steering committee and all cutting and packing community, a word of recognition is deserved to whom behind the scenes made this event possible, in particular *Francisco Parreño* (University of Castilla-la-Mancha) and *Antonio Martinez* (University of Southampton).

The Coronavirus pandemic has significantly disrupted lives and work globally including the way we work in higher education. The lessons we have learnt from running *ESICUP online* are most likely similar to those across other disciplines. While we can present our work and interact through online conference platforms, it is very difficult to replicate the experience of informal discussions over coffee and meals that often lead to new collaborations and research networks. However, there are many opportunities arising from running a meeting online such as more easily including interesting keynote speakers from across the world. Also the meetings are more inclusive allowing those who cannot afford the time or money to travel to be able to attend. The conclusion is obvious, we need to find a way to embrace the best of both worlds.



Next year we will meet face-to-face in Toledo during the spring (date to be confirmed). You are all invited to travel and meet this active and friendly community. However, we wish to take advantage of the lessons learnt from this online event, and we are seeking out ways of keeping the meeting accessible to researchers from farther countries. 🌍

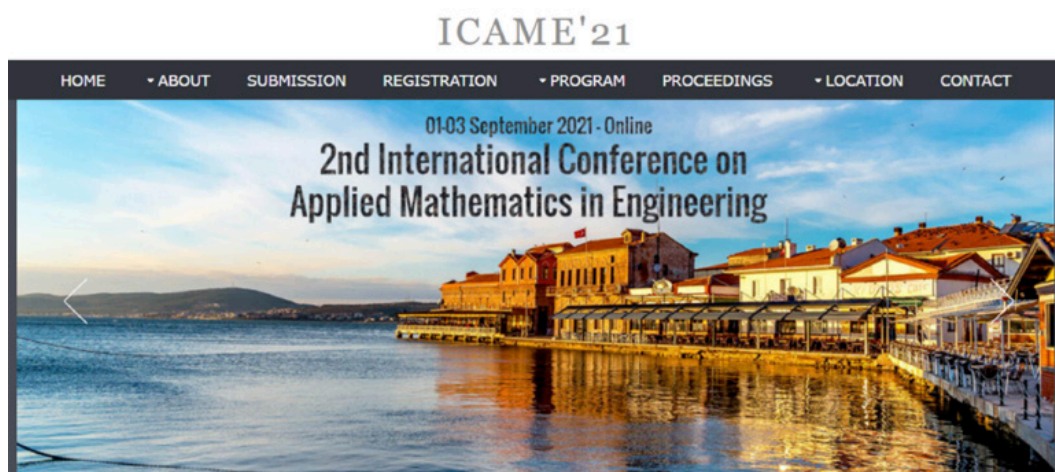


▲ A virtual “coffee-break” during the meeting.

## OR Scientists Meet at a Multidisciplinary Conference ICAME'21, Turkey, Online

**Burcu Gürbüz** <burcu.gurbuz@uni-mainz.de>; **Fırat Evirgen** <fevirgen@balikesir.edu.tr>;  
**Ibrahim Kucukkoc** <ikucukkoc@balikesir.edu.tr>; **Necati Ozdemir** <nozdemir@balikesir.edu.tr>;  
**Gerhard-Wilhelm Weber** <gerhard.weber@put.poznan.pl>

The *Second International Conference on Applied Mathematics in Engineering (ICAME'21)* was successfully held online during September 1-3, 2021 (<http://icame.balikesir.edu.tr>). Following the successful organization of the *ICAME'18*, *ICAME'21* was also a well-organized and productive conference even though it is an online version due to the COVID-19 circumstances.



▲ The official web site of the *ICAME'21* (<http://icame.balikesir.edu.tr>).

*ICAME'21* aimed to bring together leading researchers and academics in the field of applied mathematics and engineers to debate current and interdisciplinary topics in control, fractional calculus, optimization, and their applications in engineering science. The first conference took place in 2018 and was one of the defining multidisciplinary approaches of *ICAME*. Since then it has been decided for the next conference in 2020 which was planned to be once in two years organization. However, due to the worldwide unusual COVID-19 pandemics situation in 2020, the conference was postponed for 2021.

*ICAME'21* has been excellently organized thanks to the leadership of *Prof. Dr. Ramazan Yaman*, *Prof. Dr. Necati Ozdemir*, and the co-chairs of the conference, as well as the devoted and hard work of the Organizing Committee Members. A delightful and rich program has been prepared for the attendees of *ICAME'21*. During the conference, 9 special sessions: Modelling and Optimization in Engineering, Operational Research,

Control Theory and Applications, Fractional Calculus with Applications in Biology, Numerical Methods in Fractional Calculus, New Fractional Derivatives and Their Applications, Nonlinear Dynamical Systems and Chaos, Nonlinear Transport Phenomena and Models, Computational Methods for Treatment of Linear and Nonlinear Models have been proposed to the participants. The special sessions were successfully organized and gave the attendees precise understanding and careful selection by including the contributed studies to the regarded sessions.

About 120 people from 27 different countries were registered to the conference. It is an impressive detail that all the sessions were rigorously followed by the attendees of the conference. With 6 plenaries and 4 invited speakers of prestigious international scientists, more than 140 contributed presentations, and several other scientific events, *ICAME'21* has offered a productive and remarkable experience to international researchers from all around the world.



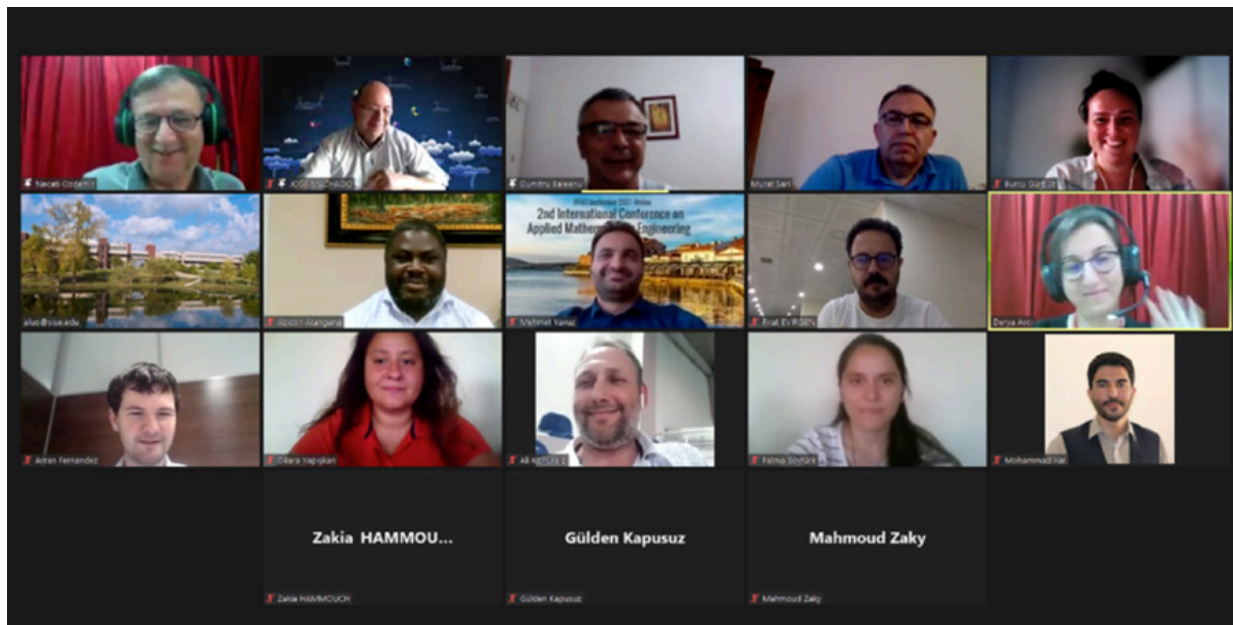


▲ The Local Organizing Committee members with the Chair Persons of the ICAME'21 (from left to right); Fatma Soytürk, Dilara Yapiskan, Derya Avcı, Necati Özdemir, Metin Demirtas, Ramazan Yaman, Gülşen Yaman, İbrahim Küçükkoç, Fırat Evirgen, Mehmet Yavuz, Mustafa Akdemir and Haris Çalgan.

The Plenary Speakers of the ICAME'21 with their titled talks were as follows: Prof. Dr. Albert C. J. Luo (Southern Illinois University Edwardsville, USA): "Infinite Unstable Periodic Orbits to Infinite Homoclinic Orbits in the Lorenz System", Prof. Dr. J.A. Tenreiro Machado (Institute of Engineering, Polytechnic Institute of Porto, Portugal): "The Logical Song", Prof. Dr. Sverre Holm (University of Oslo, Norway): "Fractional Wave Equations and Complex Acoustic Media", Prof. Dr. Gerhard-Wilhelm Weber (Poznan University of Technology, Poland): "Defined Contribution Pension Funds by Robust Stochastic Optimal Control", Prof. Dr. Praveen Agarwal (Anand International College of Engineering, Jaipur, India): "Certain Generalization of Fractional Derivative Operators". Moreover, Invited Speakers

of the scientific event with their studies were, respectively: Prof. Dr. Jordan Hristov (University of Chemical Technology and Metallurgy, Bulgaria): "Fractional Operators with Non-Singular Memories in Viscoelasticity: Basic Concepts Applicable to Linear and Non-Linear Viscoelasticity", Prof. Dr. Carla Pinto (School of Engineering, Polytechnic Institute of Porto, Portugal): "Tackling specificities of different diseases using within-host models", Prof. Dr. Hüseyin Merdan (TOBB University of Economy and Technology, Turkey): "Nonlinear dynamics of a ratio-dependent prey-predator model: Stability, bifurcations, and chaos", Prof. Dr. Amin Jajarmi (Department of Electrical Engineering, University of Bojnord, Iran): "Recent developments in the mathematical modeling and control of biological systems".

▲ Derya Avcı, Necati Özdemir and Ramazan Yaman are introducing the program. Chair of the session, Gerhard-Wilhelm Weber, and the Invited Speaker Hüseyin Merdan on his talk.



▲ Necati Özdemir, José Teneiro Machado, Dumitru Baleanu, Murat Sarı, Burcu Gürbüz, Abdou Atangana, Mehmet Yavuz, Firat Evirgen, Derya Açı, Arran Fernandez, Dilara Yapişkan, Ali Konuralp, Fatma Soytürk, Mohammad Yar, Zakia Hammouch, Gülden Kapusuz, and Mahmoud Zaky are in the end of Round Table Session.

Besides, multidisciplinary approach of the presentations, OR related studies enriched the event. Throughout the conference, OR activities and regarded works were presented in the two days activity of the “Operational Research” special session. Prof. Dr. Weber, Dr. Kucukkoc, Dr. Janardhanan, and Dr. Rossit chaired the special sessions successfully. The participants of the conference had an interest in the topics and some presentations led the future collaborations between the OR research scientists.

The well-organized scientific conference provided an opportunity for the participants to discuss and communicate with each other in a friendly environment. The participants connected from different parts of the world and were very warmly welcomed, though the scientific event was settled online. Thus, they were extremely grateful for being part of the scientific event. As in its pioneering event, high-quality papers will be selected for possible publication in esteemed journals including *International Journal of Optimization and Control: Theories & Applications (IJOCTA)*, *Journal of Computational and Applied Mathematics (JCAM)*, *Mathematical*

*Modelling of Natural Phenomena, Numerical Algebra, Control and Optimization (NACO)*; a book to be published by Springer and the conference proceedings.

On the other hand, we regret to learn that dear esteemed scholar Professor J.A. Tenreiro Machado left us shortly after the ICAME’21. He was a distinguished professor and scientist, one of the key scientific contributors to the ICAME conference series. Although no words can ease the loss which his family, colleagues, friends, and our community bear, we know he is very close to us in our memories and prayers.

The next ICAME conference is planned to be in 2023, as it is suggested to be organized once in two years. This information is also given to the attendees for inviting them to consider this exciting conference series into their future plans. The participants were also informed about the upcoming OR activities, e.g., EURO 2022 – The 32nd EURO Conference at Aalto University, Finland, July 3-6, 2022 (<https://euro2022espuu.com/>), coorganized by the Finnish Operations Research Society (FORS). 🌍

## The second year online: GTM 2021 – 15th celebration of “Game Theory and Management” in Saint Petersburg

**Leon Petrosyan** <l.petrosyan@spbu.ru>; **Nikolay Zenkevich** <zenkevich@gsom.spbu.ru>; **Elena Parilina** <e.parilina@spbu.ru>

On June 23-25, 2021, the 15th International Conference “Game Theory and Management” (GTM 2021) was held at Saint Petersburg State University (<https://english.spbu.ru/>), Russia, in online format. As usual, the conference was organized with the support of Saint Petersburg State University and The International Society of Dynamic Games (Russian Chapter).

This is the 15th issue in the “Game Theory and Management” series held at Saint Petersburg State University since 2007. This year it was a unique event because we celebrated an

anniversary and two of the plenary speakers, Professor Robert Aumann and Professor Leon Petrosyan, who were the plenaries at the 1st GTM conference in 2007, presented again this year regardless of pandemic circumstances. Our annual international conference on game theory and its applications in operational research (OR) and management science traditionally holds in Saint Petersburg, Russia. It joins together specialists in mathematical modeling, game theory, OR and theory of dynamic games, and it is supported by both the Game Theory Society and the International Society of Dynamic Games.



The *GTM 2021* conference was traditionally organized under the guidance of a permanent international Program Committee chaired by Prof. Leon Petrosyan and Prof. Nikolay Zenkevich. The participants of the 15th International conference “*GTM 2021*” gave their talk covering different areas of scientific research in applied mathematics, economics, management and OR included dynamic, differential, evolutionary, stochastic, network and cooperative games, as well as game theory applications such as mechanism design of the contracts in electricity markets, MANET performance optimization, modeling of supply chain contracts, problems in competitive international trade, coordination in fiscal and monetary policies, product differentiation and quality costs, opinion spreading in social networks, fish bank modeling, and many others. Besides the game-theoretical modeling, many of OR models and techniques, such as dynamic and nonlinear programming, network analysis, queueing modeling, simulations and assignment problems, were demonstrated in the works of the participants. We notice a significant increase of the number of talks using information technologies in OR including big-data analysis, social network performance, online advertising analysis, etc.

Four experts in the field of game theory and its applications in management sciences were invited to *GTM2021* as plenary speakers. They made interesting presentations: “*A Synthesis of Behavioral and Mainstream Economics*” by Professor Robert J. Aumann, The Hebrew University of Jerusalem, Israel; “*Nash to Dominant: the Natural Index of Strategic Stability*” by Professor Adam Tauman Kalai, Microsoft Research New

England, Cambridge, USA, and Professor Ehud Kalai, Kellogg School of Management, Northwestern University, USA; “*Differential Games on Networks*” by Professor Leon Petrosyan, Saint Petersburg State University, Russia; “*Advances in Durable-strategies Dynamic Game Theory*” by Professor David W.K. Yeung, Hong Kong Shue Yan University.

In total, 94 reports of 168 authors from 24 countries (Argentina, Australia, Brazil, Canada, Chile, China, Great Britain, Germany, Hong Kong, India, Israel, Italy, Moldova, Mongolia, Netherlands, Paraguay, Poland, Portugal, Russia, Spain, Switzerland, USA, Uzbekistan, Japan) and 13 regions of Russian Federation were submitted. Finally, 97 researchers representing 52 scientific

organizations participated. In total, 93 section talks (some in co-authorship) and 4 plenary talks were made. The number of registered participants was 94.

The participants from Russian Federation represented 12 cities: St. Petersburg, Moscow, Petrozavodsk, Yekaterinburg, Samara, Saratov, Novosibirsk, Irkutsk, Kazan, Izhevsk, Rostov-on-Don, and Vladivostok.

▲ Poster of the 15th International Conference “Game Theory and Management”.



▲ *GTM2021*: A snapshot of the plenary lecture by Prof. Robert J. Aumann.





▲ *GTM2021*: A snapshot of the conference participants.

In addition to plenary sessions, 21 parallel sessions were organized in the following areas: Game theory and applications to management (8 sessions), Dynamic games and applications (8 sessions), Games on networks, Innovations and coordination, Cooperative games and applications, Evolutionary games and applications, Learning in games.

The proceeding of the conference will be published in 2022. Further details about “15th International Conference Game Theory and Management (GTM-2021)” are available on

the official conference’s website <https://gsom.spbu.ru/en/research/conferences/gtm2021/>.

At the closing session, the 16th international conference “Game Theory and Management 2021” was announced. It will be held in Saint Petersburg in June 28 - July 1, 2022, as a part of “International Conference “Game Theory and Applications” (<https://gta2022.spbu.ru/>), a satellite event of “International Congress of Mathematicians ICM 2022” (<https://icm2022.org/>). 🌐

## Recent OR Innovations towards Sustainable Mobility: EWGT2021 Aveiro, Portugal

Eloísa Macedo <macedo@ua.pt>;  
Jorge Bandeira <jorgebandeira@ua.pt>



▲ *EWGT2021*: A snapshot of the conference Keynote Speakers (from left to right): Professor Jacek Zak, Professor Susana Sargento, and Professor Asad Khattak.

The *EURO Working Group in Transportation (EWGT)* has been established to provide an annual forum to share research information and experience, to support planning and management in the transportation sector, as well as to promote partnerships and joint research between institutions and organizations, leaders in the field of transportation, traffic, and logistics. Due to the current context of pandemics, the 2021 *EWGT Annual Meeting (EWGT2021)*; cf. <https://ewgt2021.web.ua.pt/>) was held online from 8th-10th of September 2021. The *EWGT2021* was designed to provide, although virtually, a networking environment among the researchers, transport

practitioners, and software developers in the transportation field with the aim of knowledge transfer, improving transportation systems and liveability involving many diverse areas related to transportation systems.

The Department of Mechanical Engineering of the University of Aveiro (<https://www.ua.pt/pt/dem>), in particular, the Centre for Mechanical Technology and Automation (TEMA) (<https://www.ua.pt/en/tema/>), was responsible for the organization of the *International Conference EWGT2021*. >>

>> The Chair of the Organizing Committee was Professor Margarida Coelho, the Program Chair was Dr. Eloísa Macedo, and the Organizing Committee included the members from the Smart Mobility team of the University of Aveiro: Dr. Jorge Bandeira, Dr. Paulo Fernandes, Dr. Behnam Bahmankhah, Professor Joaquim Macedo and MSc. Mariana Vilaça, as the Conference Manager. The EWGT 2021 was organized with the support of the University of Aveiro, the Department of Mechanical Engineering and Centre for Mechanical Technology and Automation, the Portuguese Institute of Mobility and Transportation; and CIRA - Aveiro Region, as well as with the support of the sponsor PTV Group.



▲ EWGT2021: The Opening Session with Professor Margarida Coelho and Mr. Victor Castro.

Many efforts have been made by the EWGT2021 Organizing Committee to organize such an online event with the main goal of providing a high-quality program and a good networking environment, in which all participants could disseminate their latest research advancements, exchange ideas, and promote contacts, collaborations and partnerships. At this conference, three internationally recognized speakers from Poland, Portugal and USA gave invited talks. The EWGT2021 accounted for more than 140 paper submissions, from which 124 were selected for presentation. These were divided into 30 parallel sessions focusing on topics ranging from Urban mobility innovations, Active travel modes and health, Transportation planning and traffic engineering, The future of mobility after COVID-19, Big data and machine learning in transportation, Airport and air transport operations, Energy consumption and emission modeling, Decision support analysis and operational research, to Simulation and optimization of transportation systems, among others. Three Special Sessions were also organized. The EWGT2021 Organizing Committee established contacts with top-quality Journals for consideration of Special Issues

since the topics covered in all presentations in the EWGT2021 are within the Operational Research (OR) field with applications to transportation, e.g., by the Special Issue "Selected papers from the 24th EURO Working Group on Transportation Meeting (EWGT2021)" of the Journal of ITS, "Special Section on Advances in Operations Research and Simulation in Transportation" of the IEEE Open Journal of ITS, "Modelling and Evaluation of New Paradigms of Mobility" of the Journal of Advanced Transportation, and "Selected papers of EWGT 2021" of the Journal TRIP.

The first day of the EWGT2021 started with a nice surprise to all participants: a special musical moment by the recognized Portuguese guitar player Mr. Victor Castro.

There were Words of Welcome by the Chair of the Conference, Professor Margarida Coelho, followed by Professor Paulo Ferreira, Rector of the University of Aveiro, and by Professor Robertt Valente, Director of the Department of Mechanical Engineering. Then, Professor Margarida Coelho took the floor to open the scientific event, in which Professor Riccardo Rossi, from the University of Padova, Italy, took the word about the history of the EWGT.



▲ EWGT2021: The Opening Session with (from left to right) Professor Robert Valente, Professor Margarida Coelho, and Professor Paulo Ferreira welcoming all participants.

The scientific program of the EWGT2021 included three Invited Talks, namely: "Intelligent/Smart Decision Making for Transportation & Logistics", by Professor Jacek Zak, from Poznan University of Technology - Faculty of Engineering Management, Poland; "Aveiro as a living lab for intelligent mobility and transportation", by Professor Susana Sargento, from the University of Aveiro and the Institute of Telecommunications, Portugal; "A bumpy road to driverless cars: Challenges and opportunities", by Professor Asad Khattak, from Civil & Environmental Engineering at the University of Tennessee, Knoxville, USA.



A Sponsor Session was also held on the first day of EWGT2021, conducted by the PTV Group consultants, mainly focused on advancements in mesoscopic traffic simulation with PTV tools. Along the three days of the conference, three Special Sessions were included in the scientific program: in the first day, “Anticipating impacts of autonomous vehicles” (organized by Dr. Jorge Bandeira and Dr. Eloísa Macedo, from the University of Aveiro, with the support of InFLOWence Project <http://inflowence.web.ua.pt/>); in the second day, “Toward new railway management systems” (organized by Dr. Anna Lina Ruscelli, from Scuola Superiore Sant’Anna, Italy); and on the last day, “Smart Cities and Mobility as a Service” (organized by Dr. Jorge Bandeira and Dr. Eloísa Macedo, from the University of Aveiro, with the support of PriMaaS Project <https://www.interregeurope.eu/primaas/>). The EWGT2021 accounted for more than 145 participants from 25 countries of Europe, America, Africa and Asia attended the conference, including researchers, public authorities, private companies, MSc. and PhD. students, and Postdocs. The program was constructed to focus on the latest theoretical and applications developments in the transportation field, to propose and discuss mobility challenges, exchange experience and drive policy and behavioral change for smarter, safer, inclusive and more sustainable mobility systems. The remarkable presentations in EWGT2021 covered very different areas and many approaches, perspectives and applications were shared.

In the Closing Session, the EWGT2021 Chair Professor Margarida Coelho highlighted that it was in her mind to organize such a warm in-person event in the “Portuguese Venice” - Aveiro, but, unfortunately, due to COVID-19



▲ EWGT2021: The Closing Session: the guitar player Mr. Victor Castro and Professor Margarida Coelho.

restrictions, it was not possible. Nevertheless, on behalf of the Organizing Committee, Professor Margarida Coelho expressed that all efforts were made to provide participants with an outstanding scientific program and an extraordinary environment for fruitful discussions and collaborations. The event closed with a musical moment.

The Invited Talks were recorded and the Proceedings of the EWGT2021 will be made available to the public at the conference website (<https://ewgt2021.web.ua.pt/>).

The Organizing Committee would like to express its gratitude for the valuable contribution of each keynote speaker and presenter, as well as of all participants that took the opportunity to attend and share experiences in the EWGT2021, which allowed creating very interesting discussions around the new paradigm of transportation, focusing on improving citizens' life. 🌍

## Good times and Grand Challenges at OR63 - The annual conference of The OR Society in the UK

**Rob Chidley** <[rob.chidley@theorsociety.com](mailto:rob.chidley@theorsociety.com)>

Boasting a few hundred speakers, 27 streams and 11 parallel sessions and one *virtual* ‘pub quiz’, *The OR Society's* annual conference OR63 packed a lot into three days, September 14-16, 2021 (cf. <https://www.theorsociety.com/or63/>).

The highlights came thick and fast: the opening plenary was given by *Christina Pagel*, Professor of Operational Research at University College London (UCL) and Director of the UCL Clinical Operational Research Unit. Throughout much of the COVID-19 pandemic, *Professor Pagel* had been visible in interviews and discussions on British television, bringing the operational research perspective to the urgent topics of the moment.

Qualified due to her specialism of using OR to support delivery of health services, *Prof Pagel* joined *Independent SAGE*, a group of scientists working together to provide independent scientific advice to the UK government and public on how to minimise deaths and support Britain's recovery from the COVID-19 crisis.

*“A running theme had been,”* she said of the past year in a very public scientific role, *“combining knowledge, evidence and expertise from many different areas and trying to make sense of the whole.”*



## My thoughts on measurement (and evidence)...



1. Are we measuring what matters? To whom? (what are we not measuring)
2. Do we know how to measure it objectively?
3. What else is needed to interpret the measurements / evidence?
4. What actions do we expect people to take based on the measurements / evidence (or modelling)?
5. Have we carried the relevant communities with us?
  1. Do they agree with 1?
  2. Do they trust 2?
  3. Do they understand 3 and have you communicated this clearly?
  4. Who has what power?

e.g. Long Covid, cases



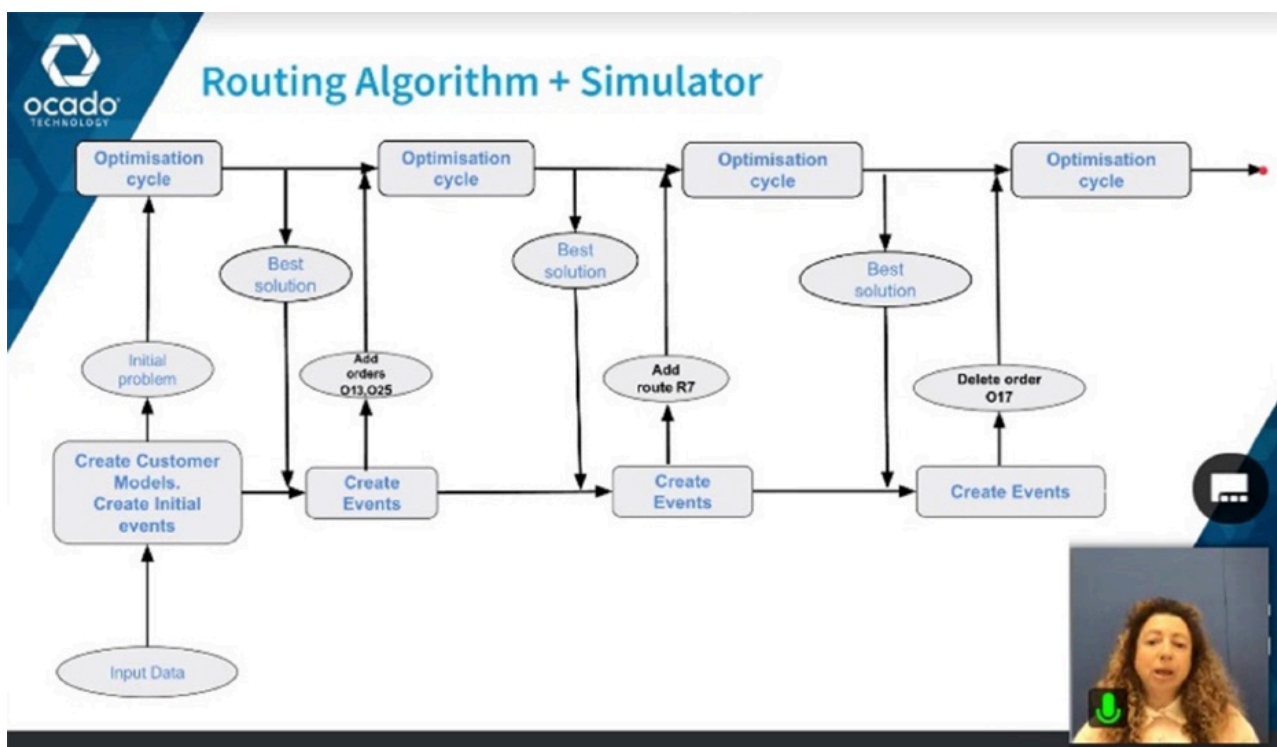
▲ OR63: Professor Christina Pagel delivers a fascinating plenary on public communications amid COVID-19.

Professor Pagel looked back at how the COVID-19 pandemic had been understood and communicated to the British Public, and looked ahead to how OR should shape approaches as the UK recovers and reconsiders its pandemic planning. It was inspirational and gratifying to know that *operational researchers* such as Professor Pagel were able to apply scientific rigour and deliver insights to government decision-making at a time of unprecedented crisis.

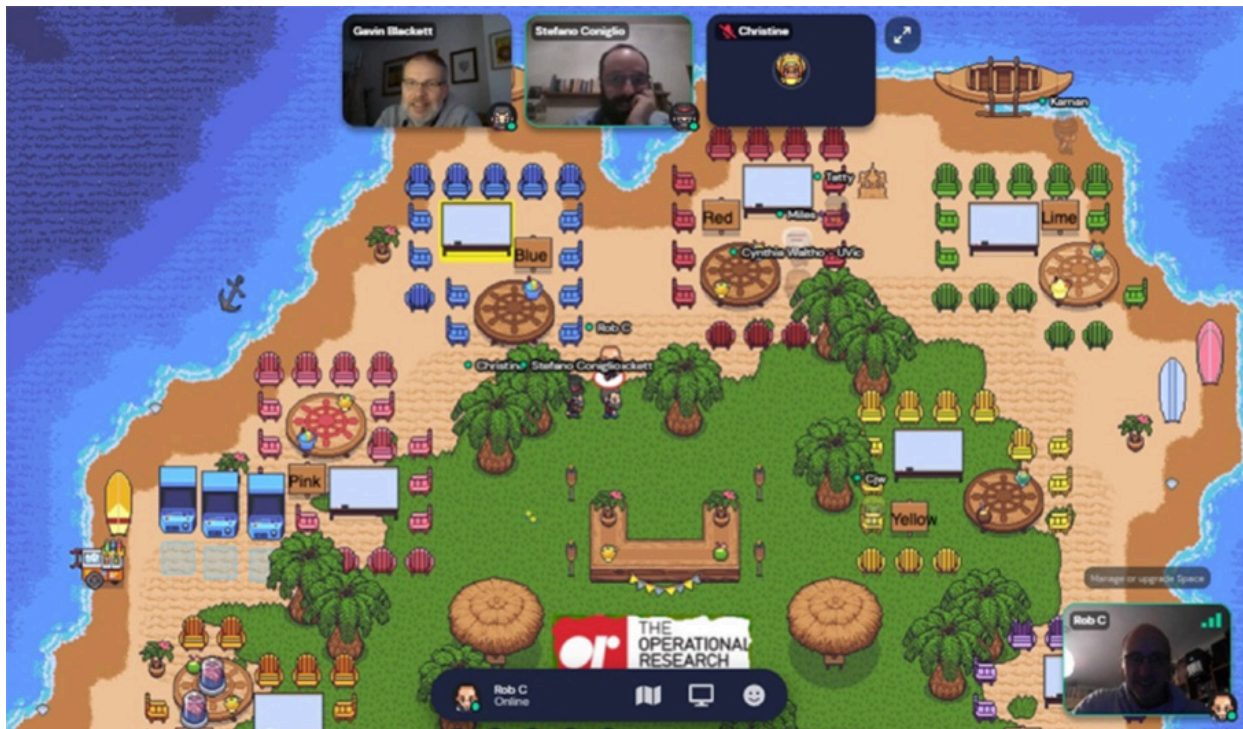
The other plenaries that ran throughout the conference were equally interesting, although not all dealt with life-and-death

matters.

Dr Anna Moss, Principal Data Scientist at Ocado Technology, brought her topic to life: *OR at Ocado: Where Efficiency Meets Social Responsibility*. Working for the 'world's largest online grocery store', Dr Moss walked the audience through some of the many complex multi-criteria optimisation problems faced by Ocado Technology, and, referencing the enormous market share won by the company, showed how OR has been intrinsic to its success.



▲ OR63: Principal Data Scientist Dr Anna Moss explores how Ocado Technology makes very profitable use of OR expertise.



▲ OR63: Delegates congregate on OR63's virtual island for a light-hearted pub quiz.

The conference's third plenary was from Government Chief Operational Researcher and Director of Analysis Ministry of Defence, *Tony O'Connor*. Due to the sensitive nature of his work, details of his talk were restricted; however, Tony explained the peaks and troughs of working as an analyst in government, and gave unique insights into how governments use data to make decisions and protect the public.

*Dr Ariella Helfgott's* much-anticipated plenary looked at *Systems Thinking for Systems Change*. "There must be space for self-interest in generative systems" such as enrichment, rest and fulfilment, *Dr Helfgott* said, as part of a wider talk on the five principles of generative systems. "We must promote the interests of the whole and the individual."

Throughout the main body of the conference, the 11 streams and 250+ speakers ensured that there was something for everyone at all times – including an online 'pub quiz' one evening to allow delegates to relax and interact in a more light-hearted setting.

It can be challenging to measure the 'atmosphere' of an online conference. At its in-person equivalent, this could be done by listening to the buzz of conversation over coffee in between sessions, or by the enthusiasm of applause or even by the energy of dancers at the after-dinner disco.

For OR63, the 'atmosphere' could be seen in the social media interactions with #OR63 and other similar hashtags. Interactions were warm and encouraging, and many sessions were spontaneously 'screen-capped' and posted online, with celebratory comments about how good the content was. The pub quiz, on our virtual island, was a hit with attendees - despite the unproven accusation of cheating by the yellow team, which I think really just added to the fun.

The vocal positivity from delegates was very encouraging at the time and - barring the expected reports on some technological issues - the post-event feedback was generally

very positive.

Throughout the three days, the variety of topics and the mix of practitioner and academic perspectives certainly made the case that OR has enormous impact in all areas and at all levels of society. One of the most ambitious aspects of this was the conference's *Grand Challenge* stream, in which questions of society-wide or worldwide importance are posed and answered from the OR perspective.

This year's grand challenge tackled business growth, vaccination services and, arguably, the biggest question of them all: 'How can OR help beyond COP26 in the transition to a net zero carbon future?' As happens every year, the grand challenges result in projects that go beyond the conference itself and create real-world outputs and insights – and this year is no different. For many, however, the true highlight of the conference is the *Presidents Medal session*, in which three presentations are made, detailing impactful projects that demonstrate successful OR practice. The medal is one of the highest honours awarded by *The OR Society* (in the UK) and, this year, treated delegates to the exploration of the following fascinating topics. The first of these was Improving the operation of COVID-19 large vaccination centres using operational research by *Christos Vasilakis*, School of Management, University of Bath (presenter), *Richard Wood*, *Simon Moss* and *Ben Murch*, NHS, Bristol, who developed a versatile tool (*PathSimR*) for modelling pathway capacity in NHS organisations.

The objectives in the study on improving vaccination centres using *PathSimR* were to detect where bookings were too high, which could result in unmanageable queues being formed, or too low, resulting in vaccines being wasted. All recommendations were implemented, and this helped ensure public confidence at crucial early stages of the project. It was noted too, that *PathSimR* could provide timely analysis for stakeholders with insights that supported critical decision-making.



Wider context: SIMTEGR8
SIMTEGR8

- National Policy Implementation: Better Care Fund (BCF)
  - A pooled budget between NHS and Local Authority Partners
  - Designed to promote joining up care pathways between health and social care.
- In Leicestershire: Commitment by local authorities to independent evaluation of BCF, one of the first places in the country to do so

▲ OR63: Dr Antuela Tako delivers her team's presentation that won them the prestigious President's Medal.

The second presentation on Local Access Support for Remote Schools was given by Rachel Tadd (Department for Transport) and Peter Stopford (Department for Education). They reported how geospatial analysis could be used to support small, remote schools with greater levels of funding for development. Many children in remote rural areas have very long journeys to school due to geographical barriers, such as rivers and peat bogs, that make long detours necessary. The project enabled 800 more schools to access funding of £42 million to help support their pupils.

The final presentation was given by Antuela Tako, University of Loughborough, on behalf of her team. The project described The SIMTEGR8 Project which was developed for the East Midlands Ambulance Service and Leicestershire County Council and provided support to a new housing support service. The presentation showed clearly how OR can transform services providing care to vulnerable communities; in this

case, the project reduced admissions to hospital accident and emergency (A&E) services and also improved the quality of life for elderly and vulnerable people.

The winner of the 2021 *President's Medal* was the The SIMTEGR8 Project, presented by Dr Antuela Tako.

Planning is already underway for OR64, the annual conference of *The OR Society* (in the UK), which will take place in Warwick, England, in 2022. Although the majority of its members are UK-based, the society welcomes members from all over the world and, now that most workplaces and conferences are moving to hybrid working, there is no reason why colleagues from outside of the UK should not attend!

Please visit [www.theorsociety.com/OR64](http://www.theorsociety.com/OR64) to read up on this year's conference and to look out for news of the 2022 event! 🌍

## The 2nd International Conference on Advance Information Scientific Development - Innovatively Advancing in Jakarta

**Herman Mawengkang** <hmawengkang@yahoo.com>  
**Mochamad Wahyudi** <wahyudi.bsi@gmail.com>  
**Gerhard-Wilhelm Weber** <gerhard-wilhelm.weber@put.poznan.pl>

ICAISD 2021 is an International Conference for sharing knowledge and research in *Operational Research*, Computer and Information Science and provides a platform for researchers and practitioners from both academia as well as industry to meet and share the cutting-edge development of OR, Computer and Information Science research.

The conference took place at BSI Convention Center, Bekasi, West Java, Indonesia collaboration with *Universitas Bina Sarana Informatika (UBSI)* and *APTİKOM* (The Indonesian Computer Science Higher Education Association) during August 5-6, 2021. Due to the slowness of vaccination in many countries in the world, which would potentially affect

all participants of the conference if the event was organized with physical presence required. Therefore the conference was conducted online using ZOOM. This event was the second conference in this novel conference series. The topics of the conference were dedicate to the motto from OR: "*Innovating Scientific Learning for Deep Communication*", which is of vast of importance worldwide, especially, for an emerging nation like Indonesia with its young population. This conference aimed (1) to bring together the scientists, engineers, researchers and practitioners, academicians, and civil society organization representatives in the scientific forum; (2) to share and to discuss theoretical and practical OR knowledge about innovation in computer sciences and applied mathematics.>>





▲ ICAISD 2021: cheerful poster of start-up event in difficult times.

>> Specifically, this conference can be used as a scientific forum for accommodating discussion among young researchers that mostly originated from Indonesia in the field of Computer Sciences, Applied Mathematics and, especially, OR. Therefore, some of the invited speakers and many of the regular participants at this conference were young and promising researchers that are becoming more and more well-known and reputable in the world. In fact, OR and Computer Science have served at ICAISD 2021 as our unique interface to the real-world with all of its industrial, economic, developmental and educational challenges, and as precious opportunity of the youth to getting further introduced into modern research and the international scientific community.

The keynote talks focused especially on the OR, Computer Sciences and Applied Mathematics. They discussed nine Main Areas of latest OR, computational and applied

mathematical issues and developments, for example, in Software Engineering, Security and Networks, Information Systems, Linguistic Computing, Computing, and Theoretical Foundations of Mathematics - with a future promise to OR applications.

There were five keynote speakers of the conference: *Prof. Zainal A. Hasibuan* (General Chair of Indonesia, APTIKOM); *Prof. Sunny Joseph Kalayathankal* (Jyothi Engineering College, Jyothi Hills, India); *Prof. Herman Mawengkang* (Universitas Sumatera Utara, Medan, Indonesia); *Prof. Dorien deTombe* (Delft Technical University, Netherlands): "Covid-19: a Pandemic that Should be Handled by the Compram Methodology"; *Prof. Gerhard-Wilhelm Weber* (Poznan University of Technology, Poland, and METU, Ankara, Turkey): "Optimization for Supply Chain Planning after Disasters with Cooperative Game Theory under Uncertainty".



▲ ICAISD 2021: Great discussions and talks with (from left to right, and top down): Dr. Taufik Baidawi, Prof. Dorien de Tombe, Prof. G.-W. Weber, Prof. Herman Mawengkang and Prof. Diah Puspitatsari.

ICAISD-2021 became a great success event, attracting researchers from ten countries and provided a great academic experience for the participants. It was attended by 150 participants, and there are more than 120 abstracts were accepted for presentation at ICAISD-2021.

The conference organizers and many of the participants have a long and cordially friendship within IFORS and EURO, especially, at their conferences with streams and sessions. In reverse, many of our IFORS friends have been invited to North Sumatra, to the city of Medan and to Lake Toba, and received hospitality in recent ten years. During the conference, Prof. Dr. Gerhard-Wilhelm Weber kindly invited to the next conference highlights of EURO 2022 in Espoo, Finland (<https://euro2022 espoo.com>).

As the "Editor in Chief" of the conference, we would like to extend my deepest appreciation to all local organizers, the team around the Conference Chair, Dr. Taufik Baidawi, who worked very hard and showed a great care and warmth, to all



▲ ICAISD 2021: Welcoming Speech by Dr. M. Wahyudi, the Rector of Universitas Bina Sarana Informatika, Jakarta, Indonesia.

the keynote speakers, participants and all the many friends from near and far. Without their support this conference was not a success. Finally, I wish you all a great success in the years to come.

Hope to see you again at The ICAISD 2022. 🌐



▲ ICAISD 2021: Interesting Talk by Prof. Herman Mawengkang.

## 8th HLF 2021: Next-Generation Dynamic Forum in Heidelberg: World's Supreme Scientists, COVID-19 and OR

**Burcu Gürbüz** <[burcu.gurbuz@uni-mainz.de](mailto:burcu.gurbuz@uni-mainz.de)>

**Gerhard-Wilhelm Weber** <[gerhard.weber@put.poznan.pl](mailto:gerhard.weber@put.poznan.pl)>

The 8th Heidelberg Laureate Forum (HLF) (<https://www.heidelberg-laureate-forum.org/forum/8th-hlf-2021.html>) was successfully held online between September 20-23, 2021, after its virtual edition last year.

HLF is a networking conference that provides interactions between the laureates of the Abel Prize, ACM A.M. Turing Award, ACM Prize in Computing, Fields Medal, and Nevanlinna Prize with 200 carefully selected young researchers in Mathematics and Computer Science, including their coverage of Operational Research. The forum is annually organized by the Heidelberg Laureate Forum Foundation (HLFF) since 2013 and is funded by the Klaus Tschira Foundation. The scientific partners include: the Association for Computing Machinery (ACM), the International Mathematical Union (IMU), and the Norwegian Academy of Science and Letters (DNVA).

Every year during HLF, the most prestigious award recipients and invited speakers give lectures concerning their research studies and hot topics in science. These talks provide the participants, particularly the young researchers, inspiration, motivation, and awareness about state-of-the-art findings and inventions. A significant part of the conference series' interdisciplinary and applied talks consists of OR contents on Complexity Theory, Discrete Mathematics, Applied Probability, OR in Medicine, Neuroscience and the Arts, and of OR-supported interfaces between mathematics, computer science and engineering.

In its 8th edition, the HLF strived to find the most effective way to connect the laureates with the young researchers in a digital format. The organization provided a powerful concept and tools to succeed with the motto "Digital. Dynamic. Interactive.">>



>> Anna Wienhard (Scientific Chair of the HLF) with her interview explained the aim of HLF as providing an interactive platform for young researchers from all over the world to meet the laureate of the most distinguished prizes in Mathematics and Computer Science (<https://youtu.be/110pkMkIVmQ>). Thus, the promising program of the HLF'21 was enriched by carefully decided flourishing sessions such as Laureate Group Sessions, Scientific Speed-Networking, Scientific Interaction Sessions, Panel Discussions, Laureate Lectures, and Discussions, Lindau Lecture, Laureate Dialogues, Poster Session, Hot-Topic Session with Fishbowl Discussions, Workshops as well as Window to the World, Networking, Warm Up Sessions, Pub Quiz, and After Party events.



▲ HLF'21: Donna Strickland is giving her talk while Anna Wienhard moderates the session.

At this year's HLF, the list of participating laureates was as follows: Scott J. Aaronson (ACM Prize in Computing, 2020), Leonard Max Adleman (ACM A.M. Turing Award, 2002), Alfred Vaino Aho (ACM A.M. Turing Award, 2020), Yoshua Bengio (ACM A.M. Turing Award, 2018), Caucher Birkar (Fields Medal, 2018), Frederick Brooks (ACM A.M. Turing Award, 1999), Edwin E. Catmull (ACM A.M. Turing Award, 2019), Vinton Gray Cerf (ACM A.M. Turing Award, 2004), Jeffrey A. Dean (ACM Prize in Computing, 2012), Whitfield Diffie (ACM A.M. Turing Award, 2015), Simon Donaldson (Fields Medal, 1986), Alexei Efros (ACM Prize in Computing, 2016), Gerd Faltings (Fields Medal, 1986), Alessio Figalli (Fields Medal, 2018), Shafira Goldwasser (ACM A.M. Turing Award, 2012), Patrick M. Hanrahan (ACM A.M. Turing Award, 2019), Martin Hellman (ACM A.M. Turing Award, 2015), Sir C. Antony R. Hoare (ACM A.M. Turing Award, 1980), Daphne Koller (ACM Prize in Computing, 2007), Leslie Lamport (ACM A.M. Turing Award, 2013), Yann Lecun (ACM A.M. Turing Award, 2018), Barbara Liskov (ACM A.M. Turing Award, 2008), Shigefumi Mori (Fields Medal, 1990), Bảo Châu Ngô (Fields Medal, 2010), David A. Patterson (ACM A.M. Turing Award, 2017), Raj Reddy (ACM A.M. Turing Award, 1994), Joseph Sifakis

(ACM A.M. Turing Award, 2007), Ivan Sutherland (ACM A.M. Turing Award, 1988), Robert Endre Tarjan (Nevanlinna Prize, 1982; ACM A.M. Turing Award, 1986), Jeffrey David Ullman (ACM A.M. Turing Award, 2020), Leslie G. Valiant (Nevanlinna Prize, 1986; ACM A.M. Turing Award, 2010), Avi Wigderson (Nevanlinna Prize, 1994; Abel Prize, 2021), and Efim Zelmanov (Fields Medal, 1994).

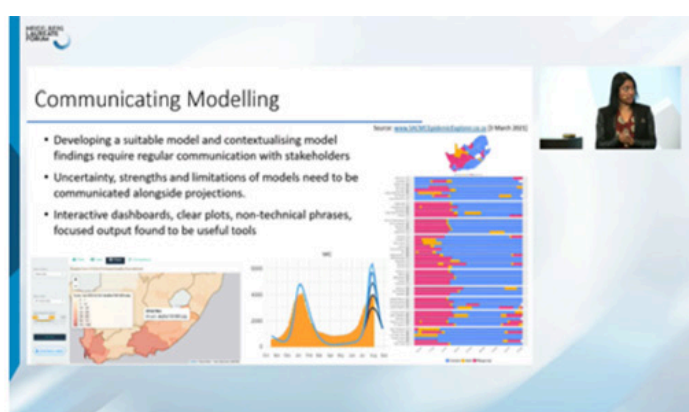
This year's HLF welcomed Donna Strickland (Nobel Prize in Physics, 2018), the guest speaker who held the Lindau Lecture. Besides her research study, she shared her experience as a very successful scientist and gave important advice to the young researchers for their career steps. At the same time, she mentioned her excitement about meeting with other laureates who have done admirable work in their fields.

Prestigious laureates gave their lectures at the 8th HLF: Avi Wigderson, Institute for Advanced Study, Princeton, "The Value of Errors in Proofs"; Scott J. Aaronson, University of Texas, "Quantum Computational Supremacy".

The "Hot Topic" Session was about an important topic affecting our lives at the moment, the COVID-19 pandemic situation. The distinguished speakers shared their significant presentations with the community. Sebastian Funk (London School of Hygiene & Tropical Medicine) presented on the help of modeling studies to policymakers and the authorities. >>



▲ Hot Topic at HLF'21: Mathematics of Disease - The Science of Epidemic Modeling: Julia Fitzner and Sheetal Silal (from left to right) gave their talks.







▲ *Laureate Dialogue* at HLF'21: Leslie Lamport, Whitfield Diffie shared their ideas on algorithms and proofs. The session was moderated by Tom Geller (from left to right; <https://www.youtube.com/watch?v=KV3YFKqclU&t=132s>).



▲ HLF'21: Whitfield Diffie, Burcu Gürbüz, Tom Crawford, and Anna Wienhard (from left to right) at the Closing Ceremony.

>> One of the tutorial speakers of the *EURO 2019*, Sheetal Silal (University of Cape Town) also presented the upcoming details of her disease modeling research and OR-based applications. Julia Fitzner (World Health Organization) shared updated details of the pandemic and the importance of accurate and robust disease models in OR researches. Amrish Baidjoe (Médecins Sans Frontières - LuxOR Unit), gave an introductory concept to the audience on medical aid and its dependency on modeling together with practical applications in OR. The session was moderated by the science journalist Martin Enserink (Science Magazine) (<https://youtu.be/6hIWX2cpXF0>).

One of the “*Laureate Dialogue*” sessions was a productive discussion between the recipients of the ACM A.M. Turing Awardee Leslie Lamport (Microsoft) and Whitfield Diffie (Center for International Security and Cooperation, Stanford). They indicated an essential point of the strong connection between Mathematics and Computer Science through proofs and algorithms. The session was moderated by the journalist Tom Geller (<https://tomgeller.com/>). Tom Crawford (University of Oxford) introduced the Program in the Daily News Show and Recap to summarize the events.

This fascinating event was organized by Ruth Wetzlar, the Managing Director of HLF, and precious members of the HLF team (<https://www.heidelberg-laureate-forum.org/about/team.html>) who turned the dreams of the young researchers into reality through their support and diligent work in the organization. In particular, the *Young Researchers Relations team* Sarah Macleod and Martina Wagner, motivated and encouraged the early-stage scholars and informed them about every single detail of the event.

Coauthor Burcu Gürbüz was selected for the event as one of the 200 young researchers from a total of 900 applicants. She had a chance to present her study outcome, a collaboration with her supervisor Alan Rendall (Johannes Gutenberg-University Mainz), on a biochemical application of a nonlinear dynamical system analysis (<https://arxiv.org/abs/2106.14732>). Her poster work on her postdoctoral research was selected as one of 20 posters for the presentation at *Digital 8th HLF* from 70 candidates. During the interactive sessions, she informed the audience about the upcoming OR event of *EURO 2022*, Espoo, Finland (<https://euro2022espo.com/>). 🌍

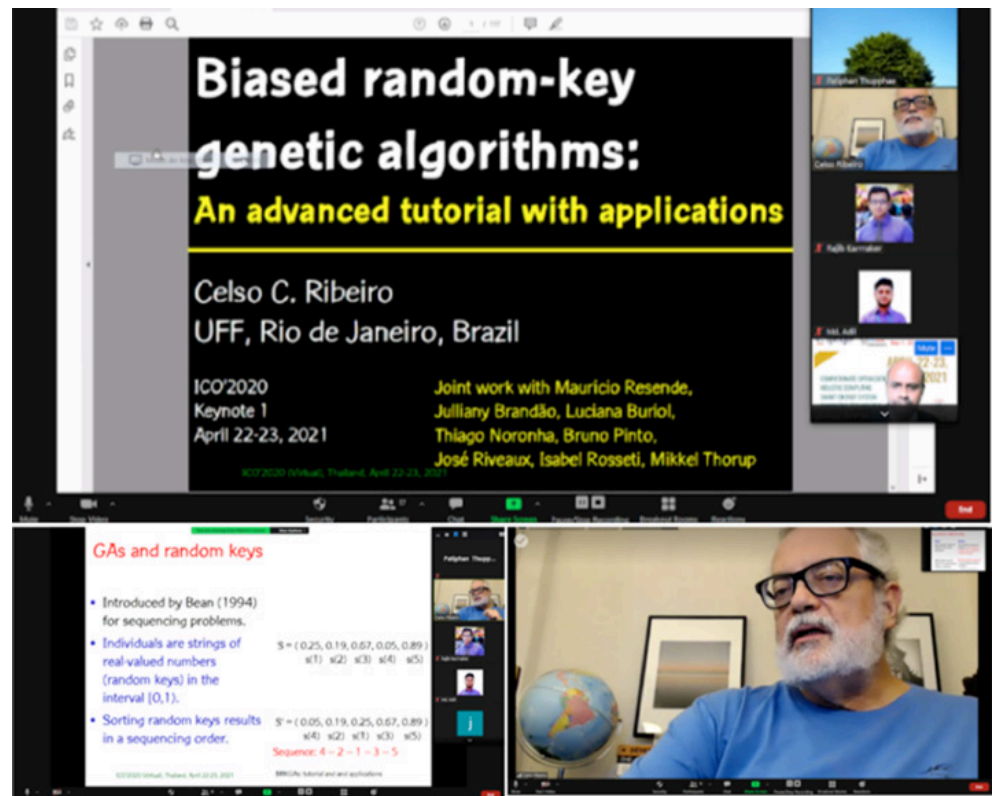
# Advances in Intelligent Systems and Computing for Intelligent Computing and Optimization – investigated at ICO'2020 Hua Hin, Thailand – in 2021

**Pandian Vasant** <pvasant@gmail.com> **Gerhard-Wilhelm Weber** <gerhard-wilhelm.weber@put.poznan.pl>  
**J. Joshua Thomas** <jjoshua@kdupg.edu.my> **Arkadiusz Kalembe** <arkadiusz.kalembe@put.poznan.pl>

The 3rd edition of the *International Conference on Intelligent Computing and Optimization (ICO)*, *ICO'2020 Virtual*, was planned to be held in October 2020 at *G Hua Hin Resort & Mall, Hua Hin*, in Thailand, but it became postponed to *April 22-23, 2021*, and celebrated remotely due to the COVID-19 pandemic. Full physical conference was put forward into the future in order hopefully soon to be held at *Hua Hin*, Thailand, after the pandemic. The objective *ICO'2020* was to gather outstanding international leaders in research, and experts and chief investigators in the fields of Intelligent Computing and Optimization from all over the world to share their insights and experiences on contemporary scientific achievements in those domains. The organizers hosted a very successful virtual conference *ICO'2020* in April 2021. This online congress provided a “golden opportunity” for our worldwide research community to collaborate and exchange their newest results and creations, their innovative findings and inventions, among and with old and new colleagues and friends. The proceedings of *ICO'2020* have been published as a compendium and book by *Springer* (under *Advances in Intelligent Systems and Computing*).

Almost 100 authors submitted their full papers for *ICO'2020*, representing more than 50 countries, including Bangladesh, Canada, China, Croatia, France, Greece, Hong Kong, Italy, India, Indonesia, Iraq, Japan, Malaysia, Mauritius, Mexico, Myanmar, Namibia, Nigeria, Oman, Poland, Russia, Slovenia, South Africa, Sweden, Taiwan, Thailand, Turkmenistan, Ukraine, the USA, the UK, Vietnam. This global attendance clearly discloses the growing research interest of the community in our *ICO* conference series.

For this edition, the conference proceedings covered innovative and original, important and future oriented research fields on sustainability and smart cities, meta-heuristics and classical optimization, cyber security and block chains, big-data analytics and IoTs, renewable energy and artificial intelligence, Industry 4.0 and modeling, Operational Research (OR) and simulation, stochastics and control. The organizing committee sincerely thanks all the authors and the anonymous reviewers for their awesome donation of excellence to our conference.



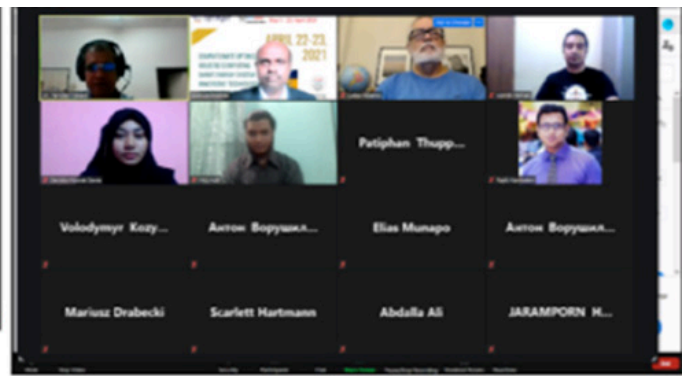
▲ *ICO 2020 (in 2021): Impressions from the Keynote Lecture by Prof. Dr. Celso C. Ribeiro.*

Best as well as highest-quality papers were reviewed and picked by the International Program Committee and become published within the “*Advances in Intelligent System and Computing*” series of *Springer* publishing house.

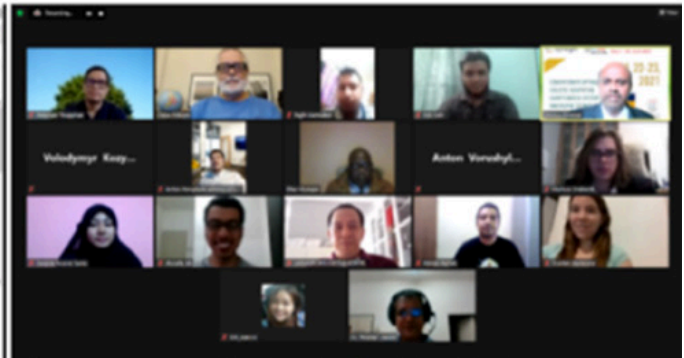
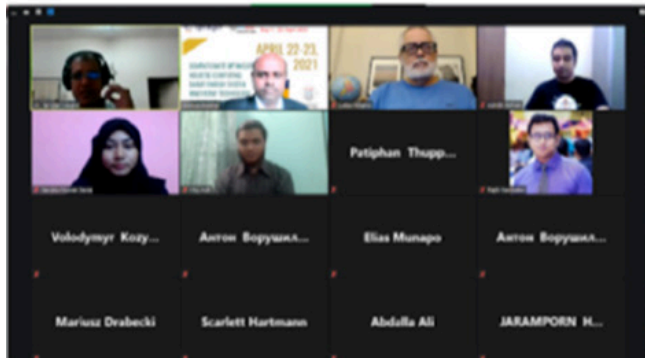
*ICO'2020* (in 2021) accommodated and featured enlightening, inspiring and paradigm-shifting contributions from and for research scholars, and from across our planet in the scientific areas of innovative computing and state-of-the-art optimization, and of cutting-edge methods and appealing applications.

*International Conference on Intelligent Computing and Optimization* represented a well-chosen collection of innovative science and engineering, management and OR, on the methodologies and uses of deep learning and optimization strategies in the areas of business and economics, games and finance, natural sciences and modern technologies. Highlighting subjects of data and hybridization, computation and modeling, artificial intelligence and analytics, this congress was ideally designed for engineers, IT specialists and data analysts, data scientists and engineers, researchers and academicians, philanthropes and policy makers who are exploring contemporary and upcoming investigations, methods, results and creations on deep learning, optimization and OR, and their emerging application in smart-technology industries and for our world of tomorrow.





Day 1  
22-April-2021



▲ ICO 2020 (in 2021): :) Lively discussions in the sessions.

This congress would not have been possible without the diligent work from the committee members of ICO'2020. For their great efforts and hard-work in organizing the special event we express our gratitude to *Prof. Igor Litvinchev* (Nuevo Leon State University, Mexico), *Professor Jose Antonio Marmolejo* (Universidad Panamericana, Mexico), *Prof. Rustem Popa* (Dunarea de Jos University in Galati, Romania) and *Dr. J. Joshua Thomas* (UOW Malaysia KDU Penang University College, Malaysia).

Furthermore, we appreciate the precious guidance and immense care and energy spent by *Dr. J. Joshua Thomas* (UOW Malaysia KDU Penang University College, Malaysia), *Prof. Valeriy Kharchenko* (Federal Scientific Agroengineering Center VIM, Russia), *Prof. Sergei Senkevich* (Federal Scientific Agroengineering Center VIM, Russia), *Prof. Celso C. Ribeiro* (Brazilian Academy of Sciences, Brazil), *Dr. Vladimir Panchenko* (Russian University of Transport, Russia), *Prof. Jose Antonio Marmolejo* (Universidad Anahuac Mexico Norte, Mexico), *Prof. Roman-Rodriguez-Aguilar* (Universidad Panamericana, Mexico), *Prof. Ugo Fiore* (Federico II University, Italy), *Prof. Elias Munapo* (North West University, South Africa), *Prof. Mukhdeep Singh Manshahia* (Punjabi University Patiala, India), *Mr. K. C. Choo* (CO2 Networks, Malaysia), *Prof. Mingcong Deng* (Tokyo University of Agriculture and Technology, Japan), *Dr. Kwok Tai Chui* (Open University of Hong Kong, Hong Kong), *Prof. Hui Ming Wee* (Chung Yuan Christian University, Taiwan), *Prof. Mohammad Shamsul Arefin* (Chittagong University of Engineering and Technology, Bangladesh), *Prof. M. Moshuiul Hoque* (Chittagong University of Engineering & Technology, Bangladesh), *Prof. Rustem Popa* ("Dunarea de Jos" University in Galati, Romania), *Prof. Ivan Zelinka* (VSB-TU Ostrava, Czech Republic), *Prof. Pandian Vasant* (MERLIN Research Centre, Ton Duc Thang University, Vietnam) and *Prof. Gerhard-Wilhelm Weber* (Poznan University of Technology, Poland).

From our hearts we would like convey our utmost cordial thanks to *Prof. Dr. Janusz Kacprzyk*, *Dr. Thomas Ditzinger*, and *Ms. Jayarani Premkumar* of *Springer Nature* for their wonderful help and support in publishing ICO'2020 conference proceedings as a book in renowned *Advances in Intelligent Systems and Computing*.

Due to the yet not fully controlled pandemic situation, the exclusive ICO'2021 will be held on December 30-31, 2021, still as a virtual conference based in *Hua Hin*, Thailand (cf. <https://www.icico.info>). The authors are carefully monitoring the development and eagerly waiting for the day to welcome us all *in person* in *Hua Hin*, Thailand, and the in some of the other most beautiful places in South-East Asia!

**About the authors:** *Pandian Vasant* serves at MERLIN Research Centre, Ton Duc Thang University, Vietnam, and as General Chair ICO'2020 / Volume editor for ICO'2020 AISC Springer Nature publication; *J. Joshua Thomas* serves at UOW Malaysia, and KDU Penang University College, Malaysia; *Gerhard-Wilhelm Weber* serves at Faculty of Engineering Management, Poznan University of Technology, Poland, *EURO* and *IFORS*, and *Arkadiusz Kalemba* serves at Faculty of Engineering Management, Poznan University of Technology, Poland.

### Conference Photos

Day 1:

<https://photos.google.com/share/AF1QipPZ-08jU26hV435LdEgXGHHWW4gj6chSgTEOqzKpP80CzPaZSiD05nbnkRTsShALDw?key=NnhRMER0cDEyUTdZSUIRMHIRY3dyOHF5QWtmRzFn>

Day 2:

[https://photos.google.com/share/AF1QipNWpSeeO9AYwg1gEm1gLokpJ5PzDo\\_2U1wLHvbC11hs6fzhITH7KenKlizXhK0rA?key=X2ZMQ1EtclDfYk51TjNrSzFxFxUk9td2dST05icmV3](https://photos.google.com/share/AF1QipNWpSeeO9AYwg1gEm1gLokpJ5PzDo_2U1wLHvbC11hs6fzhITH7KenKlizXhK0rA?key=X2ZMQ1EtclDfYk51TjNrSzFxFxUk9td2dST05icmV3) 🌐

# EURO2021 and “OR in Healthcare and Logistics” YoungWomen4OR Webinar

**WISDOM**

WOMEN IN SOCIETY:  
DOING OPERATIONAL RESEARCH  
AND MANAGEMENT SCIENCE

**Paula Carroll** <paula.carroll@ucd.ie>

**Annunziata Esposito Amideo** <annunziata.espositoamideo@ucd.ie>

**Tatiana Tchemisova** <tatiana@ua.pt> **Ozgen Karaer** <okaraer@metu.edu.tr>



▲ The figure shows top to bottom, left to right: Prof Julia Bennell (EURO VP2), Dr Paula Carroll (WISDOM moderator), panellists Dr Frances O'Brien (WISDOM Forum and UK OR Society WORAN), Dr Alberto Santini (EUROYoung), Prof Ruth Misener (EPSRC Early Career Research Fellow), Dr Giovanni Felici (European Research Council representative), Prof Renata Mansini (WISDOM moderator), and Prof Paolo Toth (former EURO president, and EURO Gold Medal winner).

## WISDOM Roundtable at EURO 2021

The EURO WISDOM (Women In Society: Doing Operational Research and Management Science) Forum organized a Roundtable and special presentations by the YoungWomen4OR at EURO 2021 to discuss networking as a strategy to help career progression and build personal influence, and to discuss how to manage work-life pressures. Panelists were invited to discuss their experiences and make suggestions, and also to discuss what they believe are appropriate metrics to measure impact in scientific and technical activities.

The panel discussed the importance of building a strong disciplinary network and strengthening ties by participating at events such as EURO conferences.

## YoungWomen4OR Webinar

WISDOM hosted a YoungWomen4OR Webinar via ZOOM on September 27, 2021, 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. During the Webinar, three EURO WISDOM YoungWomen4OR awardees delivered 10 minute research presentations on OR applications for healthcare and logistics. Dr Beatriz Brito Oliveira (INESC-TEC, Portugal) presented results of her work about the capacity-pricing problem in car rental; Dr. Lucy Morgan (BT, UK) presented a talk entitled “Modelling of waiting lists for diagnosis and treatment of chronic heart failure following the Covid-19 pandemic”, and Dr. Melanie Reuter-Oppermann (Technical University of Darmstadt, Germany) illustrated the current challenges for OR in emergency management systems (EMS) logistics.





▲ *YoungWomen4OR* presenters (from left to right): Dr Beatriz Brito Oliveira, Dr Lucy Morgan, and Dr Melanie Renter-Oppermann, and the *YoungWomen4OR* Webinar subject matter expert, Prof Stefan Nickel.

The *YoungWomen4OR* presentations were followed by a contribution from Professor Stefan Nickel (Karlsruhe Institute of Technology, Germany) who made an overview of current challenges within healthcare and logistics and highlighted possibilities for potential synergies with the speakers' existing work.

#### Future WISDOM Events

The next *YoungWomen4OR* talk on *OR in Sustainable Supply Chains and Supply Systems*, will take place on November 22, 2021, 15.00-16.30 (Central European Standard Time). In this webinar, the three guest speakers Dr. Catia da Silva, Dr. Bruna Mota and Dr. Jessica Rodriguez Pereira will be joined by the expert panelist Prof. Grit Walther.

*End of Year Celebration*: Monday, 20th December, 15.00-16.30 (Central European Standard Time) - Save the date - details to follow! 🌍



▲ A screenshot from the Webinar. Top to bottom, left to right: Dr Annunziata Esposito Amideo, Dr Paula Carroll, Dr Beatriz Brito Oliveira, Dr Melanie Renter-Oppermann, Dr Lucy Morgan, and Prof Stefan Nickel.

## US Naval Academy Optimization & OR Conference 2021 - Giving Tribute to Professors Cornelis Roos and Florian A. Potra

Goran Lesaja <lesaja@usna.edu>

#### The Conference

The United States Naval Academy (USNA) Optimization and Operations Research Conference was held virtually during June 2-4, 2021. The goal of the conference was twofold; first, to demonstrate the research and work done by USNA faculty and students, and second, to expose USNA faculty and students to the modern developments in the field of optimization theory and applications presented by leading researchers in the fields of optimization and OR.

In addition, the conference marked the occasion of Professor Cornelis (Kees) Roos' 80th birthday and Professor Florian A. Potra's 70th birthday as a celebration of their significant contributions to the field of optimization. Many world-renowned researchers who worked and collaborated with Prof. Roos and Prof. Potra, participated and presented at the conference, as well as a number of their former students who are well established researchers in their own right.



▲ Honored at USNA Optimization and OR Conference 2021: Professor Kees Roos (left) and Professor Florian Potra (right).



▲ *USNA Optimization and OR Conference 2021: the informative and welcoming homepage.*

The conference was sponsored by the USNA Department of Mathematics. We acknowledge the help and support of the Department of Mathematics Chair, *Prof. Zarikian*, and *Capt. Eric Woelper*, Dean of the School of Mathematics and Science, who opened the conference. It was also sponsored by the activities of the *William R. Davis Distinguished Chair in Mathematics* established by the generous gift of *William R. Davis*, who graduated with the USNA Class of '68 and is a former submarine officer.

The conference was organized by the *Organizing Committee* from the USNA Department of Mathematics: *Goran Lesaja*, *William R. Davis Distinguished Chair* and *Professor (Chair)*,

- *Professor Arkadi Nemirovski*, Georgia Institute of Technology, USA: *"Tight semidefinite relaxations"*,
- *Professor Yuri Nesterov*, Université Catholique de Louvain, Belgium: *"Acceleration abilities of path-following schemes"*,
- *Professor Kees Roos*, Technical University of Delft, the Netherlands: *"A new road to polynomial methods for linear optimization"*,
- *Professor Tamás Terlaky*, Lehigh University, USA: *"Quantum Interior-point methods for linear optimization"*,
- *Professor Stephen Wright*, University of Wisconsin-Madison, USA: *"The role of complexity bounds in optimization"*.

The conference had 46 speakers (41 speakers in sessions and 5 plenary speakers) and 94 registered participants. It was envisioned to be wide in scope. However, the research expertise of the majority of the external speakers was in the area of interior point methods and conic optimization that are closely related to the areas of expertise of *Prof. Roos* and *Prof. Potra*. While the conference had this partial "theme", there were strong



▲ *OC of USNA Optimization and OR Conference 2021*  
(from left to right): *Prof. G. Lesaja*, *Prof. R. Curry*, *Prof. C. Lourenco* and *Prof. A. Svirsko*.

and Assistant Professors *Rob Curry*, *Chris Lourenco*, and *Anna Svirsko*.

The conference featured five plenary talks and fourteen 90-minute sessions having three different speakers. The 6th plenary session featured conversation and reflection on *Prof. Roos'* and *Prof. Potra's* careers by their colleagues, collaborators, and students. The *Plenary Speakers* were world renowned researchers in the field of optimization:

sessions and talks covering exact methods, theory of Newton's method, network optimization, applications of optimization and OR in military, engineering, health systems, and disaster relief.

For more details please visit the conference website, <https://sites.google.com/usna.edu/usna-or-conference/home>, which includes the biographies, titles and abstracts, and slides of the talks for the plenary speakers, as well as the titles and abstracts for all other conference talks.



### A Special Issue of JOTA

In conjunction with the conference and to recognize the significant and far reaching contributions of *Prof. Roos* and *Prof. Potra* to the field of optimization in general and to the area of interior-point methods in particular a Special Issue entitled *Conic Optimization and Interior Point Methods: Theory, Computations, and Applications* of the Journal of Optimization Theory and Applications (JOTA) has been established <https://www.springer.com/journal/10957/>. The guest editors are:

- *Tibor Illés*, Corvinus University of Budapest, Budapest, Hungary, [tibor.illes@uni-corvinus.hu](mailto:tibor.illes@uni-corvinus.hu),
- *Florian Jarre*, University of Düsseldorf, Düsseldorf, Germany, [jarre@hhu.de](mailto:jarre@hhu.de),
- *Etienne de Klerk*, University of Tilburg, Netherlands, [E.deKlerk@tilburguniversity.edu](mailto:E.deKlerk@tilburguniversity.edu),
- *Goran Lesaja*, Georgia Southern University and US Naval Academy, USA, [goran@georgiasouthern.edu](mailto:goran@georgiasouthern.edu) and [lesaja@usna.edu](mailto:lesaja@usna.edu).

The guest editors invite contributions within the broad scope of the Special Issue. The contributions that are directly or indirectly related to the work of *Prof. Roos* and *Prof. Potra* are especially encouraged. Submission Deadline is January 31, 2022. 🌍



▲ Plenary speakers of USNA Optimization and OR Conference 2021 (from left to right, and top-down): *Prof. A. Nemirovskii*, *Prof. Y. Nesterov*, *Prof. K. Roos*, *Prof. T. Terlaky* and *Prof. S. Wright*.

## ORSSA/AFROS Conference 2021 – Bringing Africans together through OR!

**Dave Evans** <[president@orssa.org.za](mailto:president@orssa.org.za)>; **Hatem Masri** <[president@afrosocieties.org](mailto:president@afrosocieties.org)>

**Sue Merchant** <[suemerchant@hotmail.com](mailto:suemerchant@hotmail.com)>



▲ ORSSA/AFROS 2021: *Hatem Masri* and *Dave Evans* celebrating virtually the end of a great event!

After much hard work by the organizing team, led by *Marius Smuts* from ORSSA (South Africa's OR Society), ORSSA's 50th conference was held jointly in collaboration with AFROS (the African Federation of OR Societies) from 12th to 15th September 2021, attracting some 150 delegates. These hailed from a range of countries across the continent and further afield, with some delegates' registration fees (from AFROS' chapters and African working groups) being kindly supported by EURO, the UK OR Society, and IFORS. In addition, INFORMS provided invaluable advice in selecting an appropriate

conference virtual platform (REMO).

Other South African sponsors of the conference included: Blue Stallion Technologies; Spatial Edge; The North-West University (NWU); The NWU Centre for BMI; The NWU Department of Statistics; The NWU Focus Area for Pure and Applied Analytics; The NWU School for Industrial Engineering; The Department of Statistical Sciences at the University of Cape Town; and The Department of Industrial Engineering at Stellenbosch University.

50th ORSSA Conference in collaboration with AFROS - Analytics for Sustainability  
Auditorium

LIVE 31

Speakers

Stuart McMaster

### Model findings: Evaluating mitigation methods

Evaluation of future protected areas in 2039:

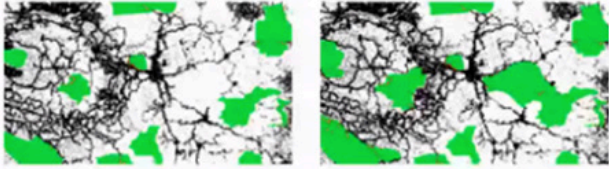


Figure: Prediction with current protected areas.

Figure: Prediction with proposed protected areas.

50th Annual ORSSA Conference — 14 Sept 2021 SIMULATING DEFORESTATION 11/13

▲ ORSSA/AFROS 2021: from the talk by *Stuart McMaster* (Stellenbosch University, South Africa) on predicting levels of de-forestation.

We would like to give a huge vote of thanks to all our sponsors and most enthusiastic participants for helping to make the conference viable, vibrant and very successful!

The African countries taking part included: Algeria, Benin, Egypt, Ivory Coast, Kenya, Mali, Mauritania, Morocco, Senegal, South Africa, South Sudan, Tanzania, Tunisia, Uganda and

Zimbabwe and a number of African delegates currently based abroad in Singapore and Canada also participated. There were many interesting talks (93 in all) - far too many to cover here - but topics ranged from one on predicting rates of de-forestation (see the first picture below) to problems of fair pricing for coffee (see the second picture below), bus route design, patient scheduling and many more.

50th ORSSA Conference in collaboration with AFROS  
Elephant Room

LIVE 12

Speakers

Rose Karimi Kiwanuka

### Key Coffee Supply Chain Challenges

#### Coffee Prices (USD/LB) - 45 Year Historical Chart



Track back to 1983

\$1.8745 as of Sept. 9, 2021

<https://www.macrotrends.net/2535/coffee-prices-historical-chart-data>

The Alliance Africa

[www.icafrica.coop](http://www.icafrica.coop)

▲ ORSSA/AFROS 2021: from the talk on coffee production supply chain challenges in Kenya by *Rose Karimi Kiwanuka* (International Cooperative Alliance-Africa, and member of AFROS working group on Agri-food Supply Chain Management). See: *Shi, J., Zhao, Y., Kiwanuka, R.B.K., & Chang, J. (2019). Optimal selling policies for farmer cooperatives. Production and Operations Management, 28(12), 3060-3080.*



We were also most grateful to all our invited speakers who brought many new ideas to the table. These included: *Prof Gerda Claeskens* from KU Leuven in Belgium (*"Confidence distributions for most powerful inference after model selection"*), *Prof Roelof Coetzer* of North-West University (*"Continuous improvement and optimization of an ore processing value chain through application of Data Science technologies"*), and *Kim Rozwadoski Triegaardt*, who gave a wonderful presentation on her uncle, *Tom Rozwadowski*, a founder member of ORSSA, and after whom the Society's premier recognition award is given. There were also a number of excellent *INFORMS* invited speakers: *Professor Elise Miller-Hooks* (*"Investing for sustainable and resilient roadway infrastructure"*); *Professor Laura Albert* (*"Operations research with impact: a journey in public sector operational research"*); *Emma Gibson* (*"Redesigning sample transportation in Malawi through improved data sharing and daily route optimization"*); *Professor Jorge Samayoa* (*"The value of data science"*); and *Professor Hatem Masri*, who gave an inspiring talk about the future of AFROS – see two samples of his slides as shown by the two pictures below.

The main auditorium of the conference was pictured on screen along with several tables for delegates to sit around (virtually, of course). The software made it possible for individuals to travel to different tables to meet others and introduce themselves or catch up with old contacts who had not been seen for eighteen months. This was a fun way of chatting about the conference, or OR in general, and was a good feature of REMO. It reminded some delegates of the recent *IFORS* conference's beach-based random meeting facilities which were also great fun!

Thanks to all those who worked so hard to get the conference off the ground and to all participants for preparing their talks



▲ ORSSA/AFROS 2021: Two key slides from *Dr Hatem Masri's* presentation.

so well. We look forward to the next edition!

**The authors:** *Dave Evans* is the President of ORSSA, *Hatem Masri* is the President of AFROS, and *Sue Merchant* is a member of *IFORS Developing Countries Committee*. 🌍

## OR Conversations Bring Enlightenment and A Clamor for More – Online Technical Forum in Manila, Philippines

Malu de Guzman U <malu\_de\_guzman@yahoo.com>

After a series of forums on special OR topics, the September 8 *"Operations Research Society of the Philippines Technical Forum"* (<https://orSP.org.ph/september-2021-online-technical-forum-or-conversations/>) was a trip back to the basics. It was an afternoon of learning and sharing for 131 *operational research* students, teachers, and industry professionals. Even for an *online* event, participant enthusiasm was palpable. Presentations by invited speakers were followed by unprecedented breakout room discussions, a new feature of the technical series. This offered all participants an opportunity to interact and share experiences, making this webinar truly live up to its name, *"OR Conversations"*.

Hosted by ORSP Director *Juanito Chan*, the webinar was opened formally by ORSP President *Marie Shella Tan-Mariscal*. *Elise del Rosario*, past president of the *International Federation of OR Societies (IFORS)* and founding member of ORSP, then opened the afternoon sessions with *"OR: An Express Overview"*. She packed her presentation with many real-life applications she encountered as OR manager in San Miguel and beyond.

She brought to light basic OR tools within Waze, Google Maps, Amazon, vehicle routing and ride-hailing apps, and a glimpse of their mathematical formulations. She covered a wide range of applications covering supply chain, optimal restocking of ATMs, marketing in the age of TV ads and social media, as well as COVID-19 vaccine deployment and health care capacity estimation. Her concluding synthesis for the whole presentation provided a concise working definition of operational research as *"the application of analytical methods to help in decision-making"*.

The second presentation, *"On the Practice of OR"*, was delivered by *Martha Tan* and ORSP Director *Dennis Beng Hui*, both from the management consulting firm *Technopoly, Inc.* They are also both part of academe, with *Martha* as operational management in Ateneo de Manila University and *Dennis* as former chair of Department of Industrial Engineering at the De La Salle University, Manila. *M. Tan* energized the attendees with a series of questions on their demographics, interests, and challenges through *Mentimeter*.



▲ Online Technical Forum 2021: Elise del Rosario provides a brief backgrounder of OR.

*D. Beng Hui* explained the differences between OR in the classroom, where everything is well-defined, versus the volatility, uncertainty, complexity, and ambiguity one encounters when applying OR in the real world. He emphasized that in applying OR in the real world, focus is not so much on tools and techniques, but rather, on fully understanding the problem, employing systems thinking to spell out the goals not of the different compartments but of the entire organization. *M. Tan* then discussed a project with *PhilSys* to improve the systems involved in the national ID registration of 70 million Filipinos in 2021. She touched on the intricacies of the project such as dealing with data and generating evidence-based insights, subject to a demanding time frame in which to deliver results.

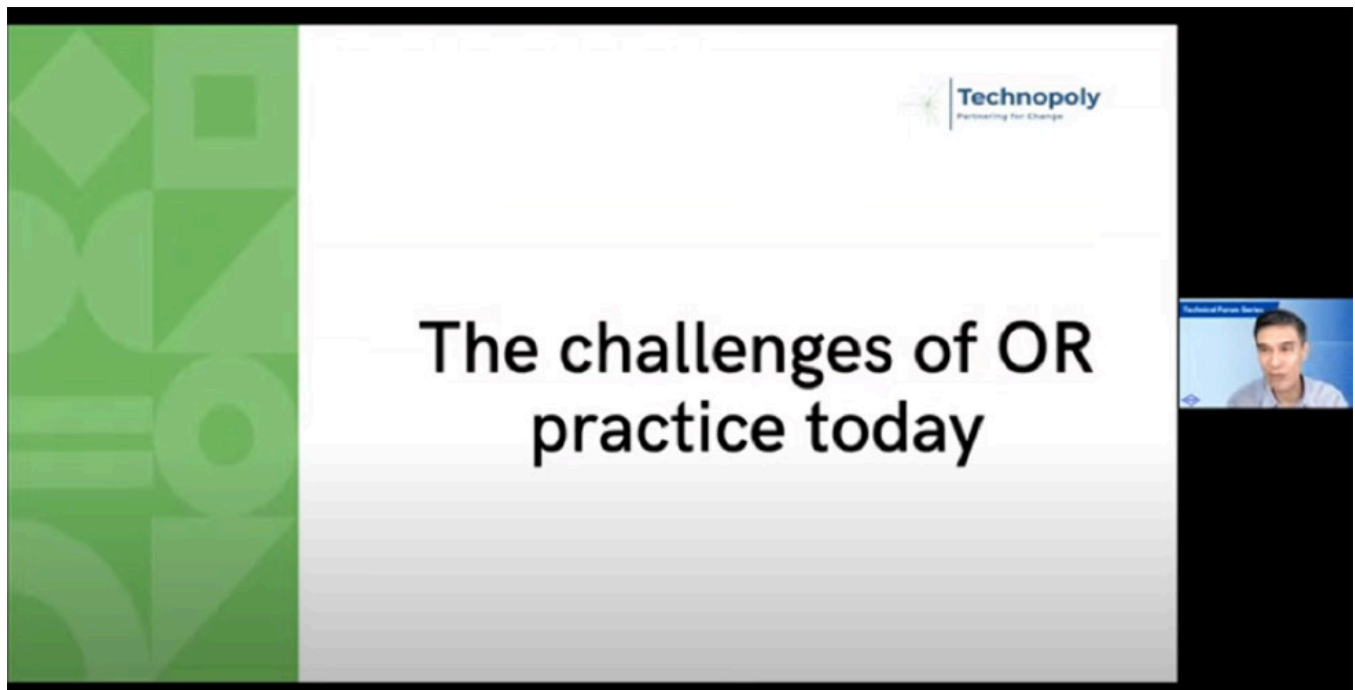
The last speaker, *Alleli Ester Domingo*, presented “On the Teaching of OR”. She shared a wealth of experience since

starting her teaching career in 1978. As a teacher of different OR subjects at the Los Baños Institute of Mathematical Sciences and Physics of University of the Philippines, she discussed how teaching has evolved through the years from merely delivering instruction to facilitating learning, and how a teacher must always focus on how students learn best. Her alumni students’ stories were inspiring to hear, especially the non-stellar ones and those who started out with little or no interest. From her classes, they grew to appreciate OR and learned not just tools of OR but also tools for success. Truly deserving each and every one of her teaching awards, *A. Domingo* quoted *Christa McAuliffe*, “I touch the future, I teach”. She ended with a quote from *Amanda Gorman*, “... that we’ll forever be tied together, victorious”, no doubt inspiring teacher and student participants, especially amidst the difficult online learning environment.

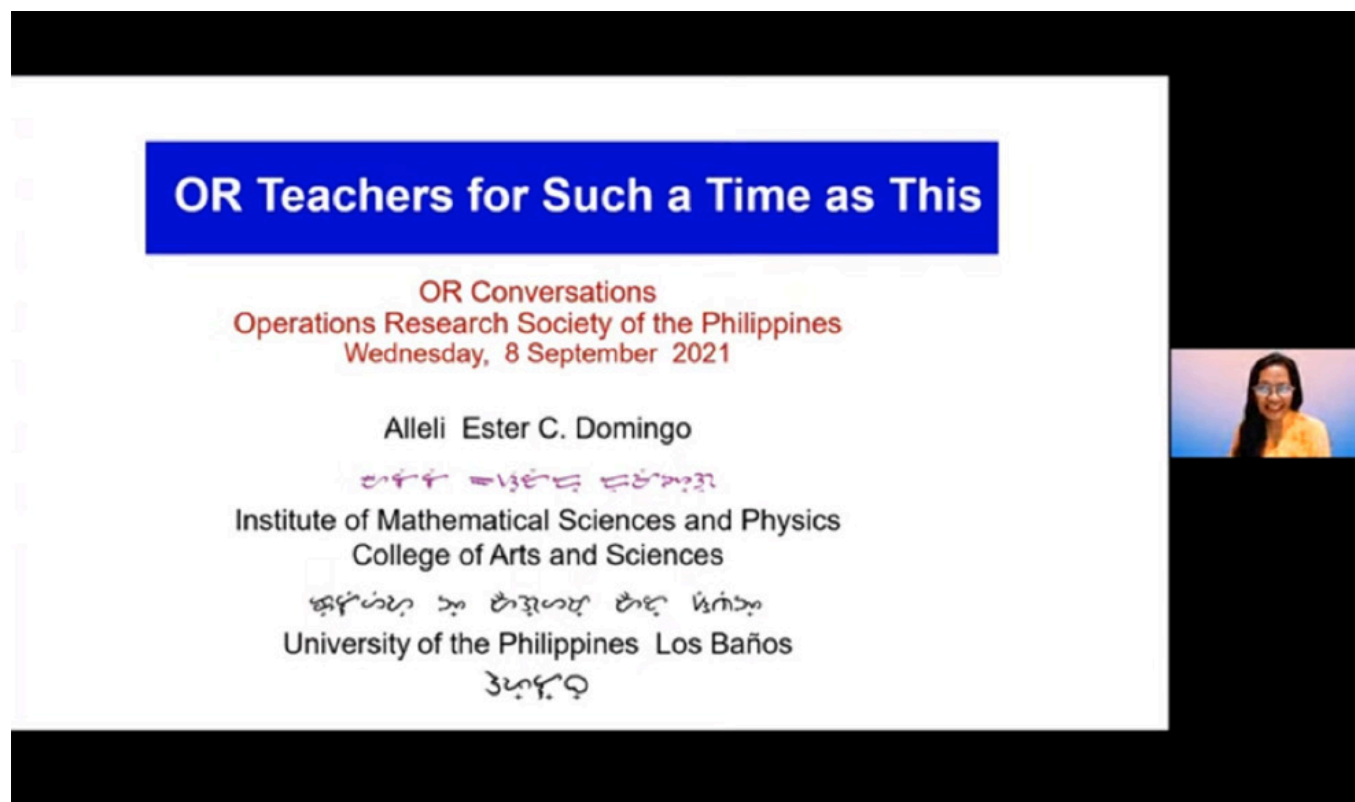


▲ Online Technical Forum 2021: Martha Tan tackles The Practice of OR through an example.





▲ Online Technical Forum 2021: Dennis Beng Hui cites the challenges faced by OR practitioners in the current milieu.



▲ Online Technical Forum 2021: Alleli Domingo shared valuable tips with teachers of OR.

At the end of the three presentations, participants were assigned to several breakout rooms, each having a facilitator and a mix of students, teachers, and industry professionals. Prior to the event, participants responded to some discussion points, such as teaching and learning methods, important OR tools, necessary skills for an OR consultant, among others. Several student attendees were curious about applications, how it differs from business analytics, how best to make classroom learning more practical. Although time was short, attendees overwhelmingly appreciated this opportunity and have requested longer discussions in future events. An open forum followed where questions collected from the Padlet wall were raised by ORSP director Nestley Sore and answered by the speakers. The webinar closed with a wrap up by ORSP

director Malu de Guzman U. Winners of the raffle prizes were informed after the forum.

Everyone rated the webinar and the speakers, excellent, only wishing that there had been more time for the breakout and Q&A with the speakers. They left the webinar encouraged and energized, realizing yet again that OR functions amidst the complexities of the modern world, and plays a crucial role in supporting decision-making. Whether it is clearly presented or hidden underneath many layers and varying sectors within an organization, or within software tools embedded in apps, OR always tries to make systems more efficient, and, in so doing, improves lives. 🌍

# Triennial IFORS Conference 2021

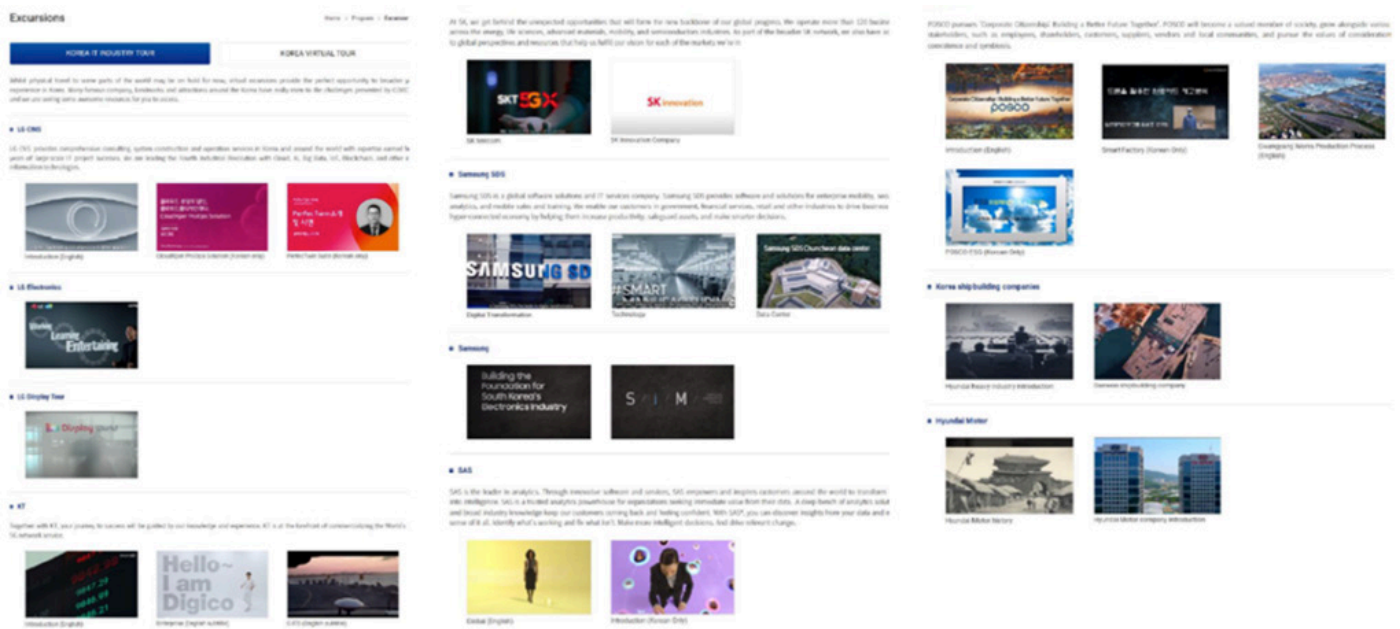
## IFORS 2021 Virtual, A Fighting Change for a Success

Suk-Gwon Chang <changsg@hanyang.ac.kr>



The 22nd Triennial IFORS conference was held virtually August 23-27, 2021 in Seoul, South Korea. It was originally planned to be held offline in late June, 2020. However, since the COVID-19 situation became worse and worse early 2020, it looked little chance that IFORS 2020 could be held as originally scheduled. The OC discussed with the IFORS AC as well as some regional representatives and reached an agreement on postponing it for a year. In this virtual conference, a total of 793 participants were registered across 53 countries, with 474 regular, 293 student and 26 waived registrations.

This conference was the first IFORS conference held online-only in all academic and non-academic events including 3 plenary, 21 parallel as well as the opening and the closing sessions. Special event like "IFORS history and beyond" and other three IFORS AC and representatives meeting were also arranged online. Industry and cultural excursions were provided virtually from the IFORS 2021 Web page. Probably, one of the most interesting events was the reception organized over a metaverse platform, called "gather town". Though it might be the first experience to most of the participants, it looked they enjoyed so much saying hello and talking to each other in this metaverse space via his/her own avatar. It should be truly an exciting and astonishing experiences to the attendees.









Following the opening session, Grazia Speranza chaired the first academic virtual session, which was the plenary talk by Robin Keller on “Building insights by modeling stakeholders’ multiple objectives”. Until at that time, the OC could not be sure about whether the pre-recorded VODs were played successfully and the Q&A between the speaker and the audience was smoothly processed without any technical problem. The OC watched impatiently what’s going on through the session and finally became saved when it finished without any complications even with over 200 simultaneous online attendees. During five-day conference period, a total of 715 presentations in 207 academic sessions were made successfully online over the Zoom platform, including three plenary and nine keynote presentations. The audience size for each session ranged between 20 and 286.

Many special arrangements were designed in advance at the planning stage of this virtual conference. One of them is to request the authors to make a pre-recorded presentation video and to upload it to the system. The presenters were asked to play his/ her video first and then had a live Q&A session together with the audience. It seems like zoom works even better than the real offline setting since it provides more intimate sense of contact among people communicating each other. The success of IFORS 2021 attributed somehow to this pre-recorded VOD policy. >>



## NUMERICAL RESULTS (I)

DMU	$\nu_{1k}$	$\nu_{2k}$	$\nu_{3k}$	$\eta_{1k}$	$\eta_{2k}$	$q_{1k}$	$q_{2k}$	$\mu_{1k}$	$\mu_{2k}$
1	0	0	0.3030	0.0152	0	0	0.0606	0.0049	0.0022
2	0	0.0337	0	0.0143	0.0279	0	0	0.0001	0.0087
3	0.0000	0	0	0.0000	0	0.1444	0.0889	0	0.0333
4	0.0513	0.0071	0	0.0109	0.0186	0	0	0.0004	0.0048
5	0.0413	0.0040	0	0.0086	0.0130	0.0064	0.0080	0.0022	0
6	0	0.0140	0	0.0140	0	0	0.0332	0	0.0104
7	0.0592	0.0058	0	0.0123	0.0186	0	0	0.0005	0.0047
8	0	0.0000	0	0.0000	0.0000	0.1000	0.0750	0.0083	0
9	0	0.0217	0.0008	0.0017	0.0254	0.0357	0.0058	0.0034	0
10	0	0	0.5919	0.0278	0.0018	0	0	0.0011	0

35 zero weights  
(proposed additive  
self-evaluation  
model)

19 zero weights  
(proposed minimax  
secondary model)

DMU	$\nu_{1k}$	$\nu_{2k}$	$\nu_{3k}$	$\eta_{1k}$	$\eta_{2k}$	$q_{1k}$	$q_{2k}$	$\mu_{1k}$	$\mu_{2k}$
1	0.0000	0	0.3030	0.0152	0	0	0.0606	0.0049	0.0022
2	0	0.0337	0	0.0143	0.0279	0	0	0.0001	0.0087
3	0.0000	0.0000	0.0000	0	0.0000	0.0882	0.1029	0.0096	0.0027
4	0.0575	0.0048	0.0089	0.0109	0.0186	0	0.0000	0.0004	0.0048
5	0.0413	0.0040	0	0.0086	0.0130	0.0064	0.0080	0.0022	0.0000
6	0.0561	0.0046	0.0041	0.0111	0.0173	0	0.0087	0.0007	0.0058
7	0.0592	0.0058	0.0000	0.0123	0.0186	0	0	0.0005	0.0047
8	0.0000	0.0000	0	0.0000	0.0000	0.0791	0.0854	0.0082	0.0019
9	0.0000	0.0217	0.0008	0.0017	0.0254	0.0357	0.0058	0.0034	0
10	0.0000	0	0.5919	0.0278	0.0018	0	0	0.0011	0

>> The OC would like to appreciate those who made as many as 638 uploaded presentations, which amounts to 89% of upload rate. Behind the scenes, many invisibles helped make IFORS 2021 virtual conference a great success. They are the session operators dedicated for each parallel session, who served sometimes as a guide, and sometimes as a trouble shooter.

IFORS 2021 virtual conference ended successfully with the great support from the IFORS president, Grazia Speranza, program committee chair, Bernard Fortz, and IFORS AC members like Karla Hoffman, Michael Trick and others. The conference truly made many interesting records in various aspects. Among them, the most interesting, probably unbreakable record is that the age of the youngest participant is less than one as you see from the picture. 🌍



# IFORS 8th GLOBAL WEBINAR SERIES. OR in Practice: Global Sports Analytics

Michael Trick <trick@cmu.edu>

Over the last 20 years, there has been a great increase in the use of analytics in sports. This use applies to both the business side of sports and to team and individual decision making. On November 18, 2021, IFORS organized a Global Webinar on this topic, and brought together four operations researchers and practitioners who are deeply involved with this increased use of analytics. The webinar, hosted by IFORS Past President Michael Trick and moderated by incoming Vice President Frits Spieksma, had as panelists:

(i) Elizabeth Wanless from Ohio University. Elizabeth is directs of the SpORts section of INFORMS, and she investigates advanced analytics application to various aspects of sport organization operations. Her presentation was about the the use and diffusion of natural language processing (NLP) in the sport industry, revealing the widespread use of NLP in major sports leagues.

(ii) Stephanie Kovalchik (Zelus Analytics). Stephanie has conducted extensive quantitative research in tennis. In her past at Tennis Australia, she worked on advancing tennis analytics. In her talk, Stephanie described, from a business perspective how a sports team, and the organization behind it can find added value using advanced machine learning techniques.

(iii) Dmitry Dagaev from the Higher School of Economics (HSE) in Moscow. Dmitry Dagaev is Head of the Laboratory for Sports Studies within the HSE. His research interests include discrete mathematics and game theory. Dmitry described the challenges of convincing leagues and sport organizations of the added value of mathematical techniques. His story ended with the description of the adoption of those techniques as the Russian Premier League adopted both the schedules and the referee assignments computed by Dagaev and his colleagues.

(iv) Mario Guajardo from the Norwegian School of Economics

(NHH), Bergen. Mario Guajardo is a Professor at NHH, and well-known, among other things, for applying integer programming tools to finding round robin schedules. In his presentation, he touched upon the impact of the pandemic on sport schedules, and how to address them.

The sixty-one participants from 19 countries in the Webinar then engaged the panelists in a spirited discussion on all aspects of analytics and sports, addressing both the technical details of their work and the larger implications of analytics in sports. The webinar, like all IFORS Global Webinars, is available free of charge at <https://www.ifors.org/ifors-global-webinar-series/> 



Global Webinar Series

## O.R. in Practice: Global Sports Analytics

November 17, 2021

9:00 am Washington DC/ 3:00 pm Rome /12:00 am (Nov 18) Melbourne

### Hosts

Michael Trick (IFORS Past-President)  
Frits Spieksma (Incoming IFORS Vice-President)

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

### Invited Speakers:



Elizabeth Wanless  
Ohio University



Stephanie Kovalchik  
ISEAL and Tennis Australia



Dmitry Dagaev  
Higher School of Economics, Moscow



Mario Guajardo  
Norwegian School of Economics, Bergen

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.

# Inventory Analytics

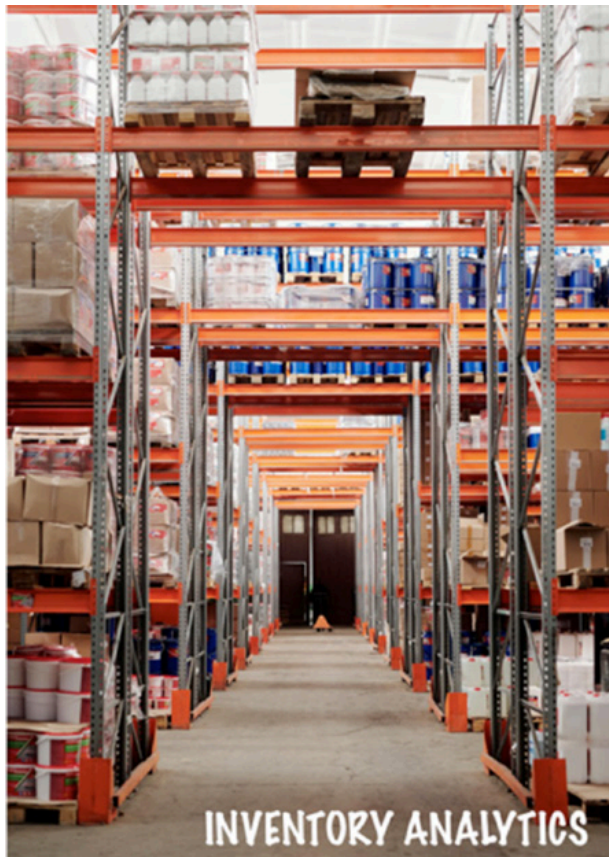
by Roberto Rossi (University of Edinburgh)

Cambridge, UK: Open Book Publishers, 2021,  
<https://doi.org/10.11647/OBP.0252>

## OR-Analytics for Management of Tomorrow

Gerhard-Wilhelm Weber <[gerhard-wilhelm.weber@put.poznan.pl](mailto:gerhard-wilhelm.weber@put.poznan.pl)>

Selma Gütmen <[selma.gutmen@doctorate.put.poznan.pl](mailto:selma.gutmen@doctorate.put.poznan.pl)>



▲ *OR-MS of Tomorrow: with Operational Research in inventory control.*

Inventory management has its roots in the practice of merchants from late Middle Ages and early Renaissance. The invention of double entry bookkeeping is generally attributed to *Frà Luca Pacioli*. He benefited from *Johannes Gutenberg's* new printing technology to popularize the accounting practices of Venetian merchants. *Frà Luca Pacioli* also interpreted these practices in the ancient rhetoric of *Cicero*. Against this historical background, it is not surprising that “analytics” found its place in inventory management early. Today that role is becoming very popular and effective. *Roberto Rossi's* book fills a void in literature on inventory theory: a basic and yet comprehensive textbook covering “descriptive” aspects on structure of inventory systems, “predictive” aspects on forecasting methods, and “prescriptive” aspects on deterministic and stochastic inventory control.

This book focusses on an analytic(s) investigation, methodological and algorithmic preparation of optimal inventory analytics and control problems arising in all areas

of modern economies, notably interacting with the areas of logistics and management of supply chains, production and waste. That requires their links to data science, machine learning, artificial intelligence and stochastics. In this vibrant field, all ecological, marketing and further managerial interfaces with environment, customers and human resources play a growing role, making this new monograph so important. Our *OR* can be named as the ideal home for such a great endeavor. This book does not require deep theoretical foundation, but it is written in an inspiring way which welcomes the reader into a training on known problems as a preparation for future application on a reader's own daily problems in inventory control. The book is rooted in a respect of real data, and based on the conviction that the needs of practitioners, but also students and scholars, have to be taken very serious. Therefore the author spent this big effort with all the coding, always having in mind a potential reader with his or her managerial works and their difficulties.

>>





Inventory control is a driving and thriving OR area; it plays a pace-making role in the wider fields of logistics and supply chain management. Therefore inventory control is appealing for both academia and industry. Selected themes of inventory control are covered at undergraduate and graduate programs. A problem with an inventory system faced by managers, is that its challenges often look simple to state but hard to tackle. This necessitates combined skills in mathematics, statistics, OR and quantitative economics. Many books in inventory control theory pursue an abstract-mathematical style that is often not helpful for practitioners or those without any further quantitative training. This work aims to fill the gap with a more applied, hands-on characteristic and without any need to resort to additional technical sources. This novel work provides seminal findings and allows to apply established models by state-of-the-art modelling languages and solvers. Basic knowledge of Python programming is a precondition of the book however. In this work, a mere technical-mathematical formalism is “minimized” whereas the needed rigor is preserved, and practical relevance and user-friendliness are “maximized”.

This work first provides a general introduction to inventory systems, and a subsequent survey of basic deterministic models. Each of those models is accompanied by an implementation in *Python* which the reader can test with motivating examples, offered throughout the book. After the showcase of models from deterministic inventory control, the reader is guided into forecasting that in existing monographs was often kept a bit small; there the reader is sometimes referred to specialized texts inaccessible for practitioners or interested ones without a special mathematical background. But forecasting can hardly be neglected today's inventory challenges. This new book reports on most well-known forecasting models in a visually appealing and hands-on way. A part on forecast errors prepares the reader for stochastic inventory control models which are presented then. Again, the prominent stochastic inventory control policies are interpreted in a pleasant, practical fashion, with helpful snippets of codes and examples. The book ends with some strong results related to control of multi-echelon inventory systems. Relevant and formal backgrounds of a number of themes that the main chapters benefit from are given in an appendix.

This timely monograph brings along a number of gains for the reader: *a.* It presents the essence of foundations which inventory control has from practical and analytical perspectives; *b.* It allows for enjoyable application of algorithmic codes provided and herewith for guidance to future application on own professional practice; *c.* It presents recent mathematical-theoretical results in analytic inventory control and their practical (Python) implementations, aiming to stimulate and facilitate own research within a broader (stochastic) frame.

Following the preface, the 6 chapters of the monograph are these: a first chapter on Introduction, a second chapter on *Inventory Systems*, a third chapter on *Deterministic Inventory Control*, a fourth chapter on *Demand Forecasting*, a fifth chapter on *Stochastic Inventory Control*, a sixth chapter on *Multi-echelon Inventory Systems*, and an *Appendix*.

This monograph is didactically very designed, help and tastefully, with clear structures in and between the chapters, self-contained and complete in its way, well exemplified and lovely arranged. It shows a balance between functionality and aesthetics. At the same time the reader is invited to further combine the content with OR system dynamics, simulation and optimal control theories, indicating the wealth of a future agenda in research and application.

This book is complemented by a comprehensive python code library released on *github* (<https://github.com/gwr3n/inventoryanalytics>) and on *pypi* (<https://pypi.org/project/inventoryanalytics/>). The author hopes that in time this library may grow further and provide a useful code repository that will enhance reproducibility of inventory research (cf. <https://dl.acm.org/doi/10.1145/3186266>).

Although the author reduced the mathematical elements of the book to the essentials, it still also is a “mathematical” book. This opens up the opportunity for inventory management scientists to understand the mathematical foundations of their discipline in a full context. This has sometimes been neglected in past research and publications. Indeed, this work has been released under a “*creative commons*” license. It is not only completely free, but its content can be reused and modified by readers - it truly is an “open source” book. The author hopes that this will encourage readers to build upon it and expand it.

Further research extension and advancement can be provided in theory, methods and applications by the author and the academic and practical communities of *OR-Analytics*. These may be stimulated and prepared by this book, with discrete-continuous or hybrid variables and parameters, gaining from newest simulation, discretization schemes, elements like thresholding, regime switching, robust optimization and control, collaborative and stochastic games. Herewith future works could also be made on accounting and financial modeling, management of natural and human resources, information and knowledge, in generalized space-times. With such advances OR will continue serving in the bio, neuro and medical, environmental, geo and space sciences, humanitarian, in developmental and societal applications, arts and humanities. 🌍

# ITOR Best Paper Award 2021

## Report on the 2020 IFORS-ITOR-Wiley Best Paper Awards

**Celso da Cruz Carneiro Ribeiro** <celso@ic.uff.br>



The winners of the 2020 IFORS-ITOR-Wiley Best Paper Awards in the categories of (a) *Surveys and tutorials* and (b) *Methodology and applications* have been selected by a committee formed by six members of ITOR's Editorial Board and a representative of IFORS' Administrative Committee. All papers published in volumes 25 (2018) and 26 (2019) were considered as potential candidates. The selection criteria consisted not only of bibliometric data about all papers, but also involved the evaluation of the committee about their contributions to the field. The following articles have been awarded after deliberation:

### Category 1: Surveys and Tutorials

#### 1) Winner:

**Isabel Narbon-Perpina and Kristof De Witte,**  
**"Local governments' efficiency: A systematic literature review - Part I", ITOR 25 (2018), pp. 431-468.**

#### 2) Runner-up:

**Xia Hu, Sean Barnes, and Bruce Golden,**  
**"Applying queueing theory to the study of emergency department operations: A survey and a discussion of comparable simulation studies", ITOR 25 (2018), pp. 7-49.**

### Category 2: Methodology and Applications

#### 1) Winner:

**Kenneth Sorensen, Florian Arnold, and Daniel Cuervo,**  
**"A critical analysis of the 'Improved Clarke and Wright savings algorithm', ITOR 26 (2019), pp. 54-63.**

#### 2) Runner-up:

**Huan Zhou, Jian-Qiang Wang, and Hong-Yu Zhang,**  
**"Stochastic multicriteria decision-making approach based on SMAA-ELECTRE with extended gray numbers", ITOR 26 (2019), pp. 2032-2052.**

The winners in the two categories have been invited to present their awarded works in a webinar titled "Excellence in Operations Research Showcase" on September 20, 2021.

The webinar was introduced by Maria Grazia Speranza (IFORS President) and mediated by Stefan Nickel (IFORS VP for publication), while Celso Ribeiro (General Editor of ITOR) reported about the prize and introduced the winners and their works. Each talk presented an overview of the awarded work and its relevance and contributions to the field of Operations Research.

In the webinar, 120 people registered among which 56 participants were from 23 different countries. The video with the full webinar is available at IFORS website at <https://www.ifors.org/> 



# Call for Applications for IFORS Scholars to attend the EURO Summer Institute on "Location Science" in Edinburgh, United Kingdom, June 11-24, 2022

The office of the IFORS Vice President for EURO is pleased to announce a sponsorship of up to two participants to join the 2022 EURO Summer Institute on "Location Science" to be held in Edinburgh, United Kingdom, June 11 -24, 2022.

The Euro Summer and Winter Institutes (ESWI) are organized to encourage good social and working relationships among promising young OR scientists.

The selected IFORS-EURO scholar(s) will receive joint sponsorship from IFORS and EURO. IFORS will sponsor the travel costs of the delegate coming from non-EURO member society. EURO will shoulder expenses related to the registration, accommodation, meals, and social activities to the IFORS fellow. Applicants from developing countries will be given preferential treatment for the slot. Those who have joined EURO Institutes in the past cannot apply.

The basic idea is that around 25 early-stage researchers, who are either PhD students or who have less than two years research experience since completing a PhD, can meet for about two weeks. All participants will have an unpublished paper within the theme announced, and will present their material, discuss it with others and with a handful of specially invited senior experts in the field, and finally prepare a paper to be considered for inclusion in a feature issue of an OR publication. The varied social program prepared for the participants is one of the unique features that enhance the learning activities.

More information on ESI 2022 can be found here: <https://www.maths.ed.ac.uk/ESI2022>



The applications should be submitted electronically through: <https://www.euro-online.org/awards/esi2022/registration.php>

Please indicate in your application that you are outside EURO and that you would like to apply for an IFORS-EURO sponsorship.

Questions regarding the sponsorship can be sent by email to:

Professor Stefan Nickel, Karlsruhe Institute of Technology  
IFORS Vice President for EURO  
Email: [vpifors@euro-online.org](mailto:vpifors@euro-online.org)

Applications should include: (1) a complete CV with a list of papers, (2) a paper proposal and (3) a letter of recommendation from one referee (preferably the thesis advisor or head of department).

## Important dates

Deadline for applications: January 10, 2022  
Notification of acceptance: February 21, 2022  
ESI: June 11 -24, 2022 🌍

## IFORS NEWS Editor in Chief: Sunity Shrestha Hada

Regional Correspondents					
ALIO	Rosiane de Freitas	Brazil	Caroline Mota	Lithuania	Leonidas Sakalauskas
APORS	Degang Liu	Canada	Dionne Aleman	Malaysia	Ilias Mamat
EURO	Gerhard Wilhelm Weber, Sarah Fores	Chile	Victor Albornoz	Mexico	Yasmin Rios
NORAM	Grace Lin, Melissa Moore	China	Degang Liu	Nepal	Sunity Shrestha Hada
Section Editors		Colombia	Elena Valentina Gutierrez	New Zealand	Andy Philpott
OR Impact	Sue Merchant/John Ranyard	Croatia	Snjezana Pivac	Norway	Marielle Christiansen
OR for Devt	Rosiane de Freitas Rodrigues	Czech Republic	Jaroslav Ramik	Netherlands	LCM Kallenberg
Tutorial	Javier Marengo	Denmark	Sanne Wohlk	Peru	Orestes Cachay Bosa
Conferences	Gerhard Wilhelm Weber	Finland	Jussi Hakanen	Philippines	Elise del Rosario
Country Correspondents		France	Luce Brotoncorne	Poland	Jan W. Owsinski
Argentina	Javier Marengo	Germany	Sebastian Rachuba	Portugal	Ana Carvalho, Tânia Ramos
Australia	Erhan Kozan	Greece	Evangelos Grigoroudis	Slovenia	Lidija Zadnik-Stirn
Austria	Karl Doerner	Hungary	József Temesi	South Africa	Martin Kidd
Belarus	Vladimir Golovko	India	N.M. Ganguli	Spain	Juan-José Salazar-González
		Iran	Nezam Mahdavi-Amiri	Sweden	Tomas Gustafsson
		Ireland	Cathal Brugha	Tunisia	Taicir Loukil
		Israel	Michal Tzur	UK	John Hopes
		Japan	Jun-ya Gotoh	USA	Jim Cochran
		Korea	Chang Won Lee	Uruguay	Carlos Testuri