ICORES 2022

11th International Conference on Operations Research and Enterprise Systems

Final Program and Book of Abstracts

3 - 5 February, 2022

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Book of Abstracts

11th International Conference on Operations Research and
Enterprise Systems

Online Streaming
February 3 - 5, 2022

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Foreword

This book contains the abstracts and final program of the 11th International Conference on Operations Research and Enterprise Systems (ICORES 2022). This conference is sponsored by the Institute for Systems and Technologies of Information, Control and Communication (INSTICC), in cooperation with the Society for Industrial and Applied Mathematics (SIAM).

The purpose of the International Conference on Operations Research and Enterprise Systems is to bring together researchers, engineers, graduate students, faculty and practitioners interested in advances and applications in the field of operations research. Two simultaneous tracks were held, one on domain independent methodologies and technologies, and the second on practical work developed in specific application areas.

This year, ICORES was held as a web-based event due to the COVID-19 pandemic, from 3– 5 February, 2022.

ICORES received 55 paper submissions from 27 countries of which 29% were accepted as full papers. To evaluate each submission, a double-blind paper review was performed by the Program Committee, whose members are highly qualified independent researchers in the two ICORES topic areas.

To recognize the best overall and student contributions, awards based on both the best reviews, as assessed by the Program Committee, and presentation quality, as assessed by the session chairs, were conferred during the closing session of the conference.

Based on reviewer evaluations and presentation quality, a short list of authors will be invited to submit extended revised versions of their papers for a book to be published by Springer containing the best ICORES 2022 papers, and in the Springer Nature Computer Science Journal.

The conference program included four invited talks delivered by internationally distinguished speakers: Nikolaos Matsatsinis (Technical University of Crete, Greece), David Ríos Insúa (ICMAT, Spain), Ivana Ljubic (ESSEC Business School of Paris, France), and Yakov Ben-Haim (Technion - Israel Institute of Technology, Israel).

We express our thanks to all participants. First to all the authors, whose quality work is the essence of this conference; and secondly to all members of the Program Committee and auxiliary reviewers, who helped us with their expertise and valuable time. We also deeply thank the invited speakers for excellent contributions in sharing their knowledge and vision. Finally, special thanks to all the members of the INSTICC team whose collaboration and coordination were fundamental to the success of this conference.

We hope to meet you again next year for the 12th edition of ICORES, details of which will soon be available at the conference website.

Federico Liberatore, Cardiff University, United Kingdom
Greg H. Parlier, NCSU, United States
Marc Demange, RMIT University, School of Science - Mathematical Sciences, Australia

Important Information

Event App
Download the Event App from the Play Store and App Store now, to have mobile access to the technical program and also to get notifications and reminders concerning your favorite sessions.

Create Your Own Schedule *
The option "My Program" gives you the possibility of creating a selection of the sessions that you plan to attend. This service also allows you to print-to-pdf all papers featured in your selection thus creating a pdf file per conference day.

Online Access to the Proceedings *
In the option "Proceedings and Final Program" you cannot only download the proceedings but also access the digital version of the book of abstracts with the final program.

Digital Access to the Receipt *
By clicking on the option "Delegate Home" and then "Registration Documents" it will enable you to access the final receipt which confirms the registration payment.

Keynotes Videos
The keynote lectures will also be available on video on the website after the event, as long as the appropriate authorization from the keynote is received, so you will be able to see them again or watch them should you have missed one.

Survey
Every year we conduct a survey to access the participants' satisfaction with the conference and gather the suggestions. You will receive an e-mail after the event with the detailed information. Your contribution will be carefully analysed and a serious effort to react appropriately will be made.

* Please login to PRIMORIS (www.insticc.org/Primoris), select the role "Delegate" and the correct event.

If you have any doubt, we will be happy to help you at the Welcome Desk.

General Information

Welcome Desk
Thursday, February 3 – Open from 10:15 to 17:15
Friday, February 4 – Open from 09:00 to 17:45
Saturday, February 5 – Open from 08:45 to 17:15

Opening Session
Thursday, February 3, at 10:30 in the Plenary 1 room.

Closing Session & Awards Ceremony
Saturday, February 5, at 17:00 in the Plenary 2 room.

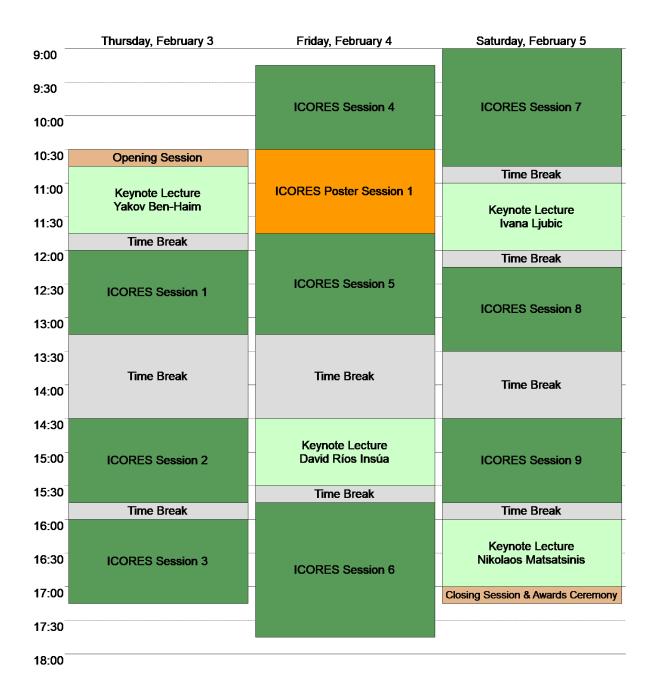**Secretariat Contacts**
ICORES Secretariat
Address: Avenida de S. Francisco Xavier, Lote 7 Cv. C
2900-616 Setúbal, Portugal
Tel.: +351 265 520 185
Fax: +351 265 520 186
e-mail: icores.secretariat@insticc.org
website: https://icores.scitevents.org

Program Layout

	Thursday, February 3	Friday, February 4	Saturday, February 5
9:00			ICORES Session 7
9:30		ICORES Session 4	
10:00			
10:30	Opening Session		Time Break
11:00	Keynote Lecture Yakov Ben-Haim	ICORES Poster Session 1	Keynote Lecture Ivana Ljubic
11:30			
	Time Break		Time Break
12:00	ICORES Session 1	ICORES Session 5	
12:30			ICORES Session 8
13:00			
13:30	Time Break	Time Break	Time Break
14:00			
14:30	ICORES Session 2	Keynote Lecture David Ríos Insúa	ICORES Session 9
15:00			
15:30		Time Break	
	Time Break		Time Break
16:00	ICORES Session 3	ICORES Session 6	Keynote Lecture Nikolaos Matsatsinis
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17:00			Closing Session & Awards Ceremony
17:30			
18:00			

Final Program
and Book of Abstracts

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Saturday Sessions: February 5

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Thursday Sessions: February 3

Thursday Sessions: February 3 Program Layout

	Plenary 1	Plenary 2
10:00		
10:30	**Opening Session**	
11:00	Keynote Lecture Yakov Ben-Haim	
11:30		
12:00		
12:30	**ICORES Session 1** #13, #40, #53	
13:00		
13:30		
14:00		
14:30		
15:00		**ICORES Session 2** #8, #19, #27
15:30		
16:00		
16:30		**ICORES Session 3** #3, #39, #48
17:00		
17:30		
18:00		

Opening Session	**ICORES**
10:30 - 10:45	Room Plenary 1

Keynote Lecture	**ICORES**
10:45 - 11:45	Room Plenary 1

What Strategic Planners Need to Know in the Age of Uncertainty

Yakov Ben-Haim

Technion - Israel Institute of Technology, Haifa, Israel

Abstract: Strategic planners need two distinct intellectual capabilities. First, extensive topical or disciplinary expertise, supported by a broad understanding of the world, is needed for dealing with complex subtleties of human affairs. Second, methodological expertise in decisions under uncertainty is needed for dealing with unique situations involving innovation, discovery, and surprise by friend or foe. We employ info-gap decision theory, and the concept of robust-satisficing, in support of strategic planning. Examples from national security, economic forecasting, and project management are presented. Three arguments support our claim. First, this dichotomy of intellectual capabilities is based on the uniqueness of historical circumstance, which often induces unprecedented behavior. Each strategic planning situation has many unique attributes of culture, geography, technology, ideology, etc. E.g. Britain's counterinsurgency (COIN) strategy in Malaya was, in many respects, quite different from its COIN in Northern Ireland, and both were different from British COIN in Kenya, Brunei, Malaysia, Radfan (Yemen) and Dhofar (in Oman). While there are generic aspects of all conflicts, historical distinctiveness and innovation are also characteristic. This makes the identification of useful concrete rules of strategy difficult. Thus, strategists need both profound understanding of human affairs and societies, and expertise in managing surprise and uncertainty. The second argument for expertise in managing uncertainty is based on Shackle-Popper indeterminism (SPI), which will be discussed. SPI provides a generic epistemic framework for understanding historical idiosyncracy and the prevalence of non-probabilistic Knightian uncertainty. The third argument is that consensus of analysts' assessments is demanded by decision makers, but pluralism of understanding is prevalent in complex uncertain environments. We propose nurturing plurality of assessment, and embedding those assessments in the analysis of robustness to uncertainty. Specifically, for any proposed policy, the analyst evaluates the robustness (of that policy) to uncertainty (plurality) of assessment. A more robust policy is preferred over a less robust policy. In order to do this, the analyst must have both topical expertise in the relevant disciplines, as well as decision-theoretic expertise in managing uncertainty.

Session 1A	**ICORES**
12:00 - 13:15	Room Plenary 1
Stochastic Optimization	

Complete Paper #13

Optimization of Adaptive Cruise Control under Uncertainty

Shangyuan Zhang[1,2], Makhlouf Hadji[1], Abdel Lisser[2] and Yacine Mezali[1]

[1] *Institut de Recherche Technologique SystemX, 8 Avenue de la Vauve, 91120 Palaiseau, France*

[2] *CentraleSupelec, L2S, Université Paris Saclay, 3 Rue Curie Joliot, 91190, Gif-sur-Yvette, France*

Keywords: Adaptive Cruise Control, Optimization, Stochastic Optimization, Autonomous Vehicle.

Abstract: With the recent developments of autonomous vehicles, extensive studies have been conducted about Adaptive Cruise Control (ACC), which is an essential component of advanced driver-assistant systems (ADAS). The safety assessment must be performed on the ACC system before its commercialization. The validation process is generally conducted via simulation due to insufficient on-road data and the diversity of driving scenarios. Our paper aims to develop an optimization-based reference generation model for ACC, which can be used as a benchmark for assessment and evaluation. The model minimizes the difference between the actual and reference inter-car distance, while respecting constraints about vehicle dynamics and road regulations. ACC sensors can be impacted by external factors such as weather and produce inaccurate data. To handle the uncertainty involved, we also propose a chance-constrained stochastic model to reach results with a high level of confidence. Our numerical results illustrate that the stochastic model outperforms the deterministic model on randomly generated driving scenarios.

Complete Paper #40

Bi-objective Risk-averse Facility Location using a Subset-based Representation of the Conditional Value-at-Risk

Najmesadat Nazemi[1], Sophie Parragh[1] and Walter Gutjahr[2]

[1] *Institute of Production and Logistics Management, Johannes Kepler University Linz, Austria*

[2] *Department of Statistics and Operations Research, University of Vienna, Austria*

Keywords: Risk-averse, Conditional Value-at-Risk, Cutting-plane, Bi-objective Optimization.

Abstract: For many real-world decision-making problems subject to uncertainty, it may be essential to deal with multiple and often conflicting objectives while taking the decision-makers' risk preferences into account. Conditional value-at-risk (CVaR) is a widely applied risk measure to address risk-averseness of the decision-makers. In this paper, we use the subset-based poly-hedral representation of the CVaR to reformulate the bi-objective two-stage stochastic facility location problem presented in (Nazemi et al., 2021). We propose an approximate cutting-plane method to deal with this more computationally challenging subset-based formulation. Then, the cutting plane method is embedded into the ϵ-constraint method, the balanced-box method, and a recently developed matheuristic method to address the bi-objective nature of the problem. Our computational results show the effectiveness

of the proposed method. Finally, we discuss how incorporating an approximation of the subset-based polyhedral formulation affects the obtained solutions.

Complete Paper #53

Nonlinear Complementarity Problems for n-Player Strategic Chance-constrained Games

Shangyuan Zhang[1,2], Makhlouf Hadji[1], Abdel Lisser[2] and Yacine Mezali[1]

[1] *Institut de Recherche Technologique SystemX, 8 Avenue de la Vauve, 91120 Palaiseau, France*

[2] *CentraleSupelec, L2S, Université Paris Saclay, 3 Rue Curie Joliot, 91190, Gif-sur-Yvette, France*

Keywords: Chance-constrained Optimization, Game Theory, Nonlinear Complementarity Problem, Normal/Cauchy Distribution.

Abstract: In this paper, we focus on n-player strategic chance-constrained games where the payoff of each player follows either Cauchy or normal distribution. We transform the Nash equilibrium problem into its equivalent nonlinear complementarity problem (NCP) through the Karush-Kuhn-Tucker (KKT) conditions. Then, we prove the existence of the Nash equilibrium by the mean of Brouwer's fixed-point theorem. In order to show the efficiency of our approach, we perform numerical experiments on a set of randomly generated instances.

Session 2A	ICORES
14:30 - 15:45	Room Plenary 2
Optimization: Theory and Methods	

Complete Paper #8

Solving Linear Programming While Tackling Number Representation Issues

Adrien Chan-Hon-Tong

ONERA, Université Paris Saclay, France

Keywords: Linear Programming, Polynomial Time Complexity, Number Representation.

Abstract: Gaussian elimination is known to be exponential when done naively. Indeed, theoretically, it is required to take care of the intermediary numbers encountered during an algorithm, in particular of their binary sizes. However, this point is weakly tackled for linear programming in state of the art. Thus, this paper introduces a new polynomial times algorithm for linear programming focusing on this point: this algorithm offers an explicit strategy to deal with all number representation issues. One key feature which makes this Newton based algorithm more compliant with binary considerations is that the optimization is performed in the so-called first phase of Newton descent and not in the so-called second phase like in the state of the art.

Complete Paper #27

Optimizing Heterogeneous Maritime Search Teams using an Agent-based Model and Nonlinear Optimization Methods

Jarrod Grewe[1] and Igor Griva[2]

[1] *Department of Computational and Data Sciences, George Mason University, 4400 University Dr Fairfax VA, U.S.A.*

[2] *Department of Mathematical Sciences, George Mason University, 4400 University Dr Fairfax VA, U.S.A.*

Keywords: Search Theory, Optimization, Search and Rescue, Agent-based Modeling, Search Planning.

Abstract: This paper introduces a new search planning methodology, nicknamed Pathfinder, that can optimize heterogeneous teams of mobile and stationary searchers. Unlike previously developed search methods, the new methodology applies an Agent-Based Model (ABM) to simulate target movement and behavior then uses nonlinear optimization methods to find optimal search plans for complex teams of searchers. We describe initial target location with a probability distribution influenced by evidence and environmental data. The ABM models target movement based on environmental and behavioral factors. Then, Pathfinder suggests a search plan that maximizes the probability of target detection and satisfies searcher requirements.

Complete Paper #19

On Solving the Minimum Common String Partition Problem by Decision Diagrams

Miloš Chromý and Markus Sinnl

Institute of Production and Logistics Management/JKU Business School, Johannes Kepler University Linz, Altenberger Straße 69, 4040 Linz, Austria

Keywords: Decision Diagram, Bioinformatics, Computational Biology, Minimum Common String Partition Problem.

Abstract: In the Minimum Common String Partition Problem (MCSP), we are given two strings on input, and we want to partition both into the same collection of substrings, minimizing the number of the substrings in the partition. This combinatorial optimization problem has applications in computational biology and is NP-hard. Many different heuristic and exact methods exist for this problem, such as a Greedy approach, Ant Colony Optimization, or Integer Linear Programming. In this paper, we formulate the MCSP as a Dynamic Program and develop an exact solution algorithm based on Decision Diagrams for it. We also introduce a restricted Decision Diagram that allows to compute heuristic solutions to the MCSP and compare the quality of solution and runtime on instances from literature with existing approaches. Our approach scales well and is suitable for heuristic solutions of large-scale instances.

Session 3A	ICORES
16:00 - 17:15	Room Plenary 2
Optimization: Management Applications	

Complete Paper #3

Searching for a Safe Shortest Path in a Warehouse

Aurélien Mombelli, Alain Quilliot and Mourad Baiou

LIMOS, UCA, 1 Rue de la Chebarde, 63170 Aubière, France

Keywords: Shortest Path, Risk Aware, Time-dependant, A*, Reinforcement Learning.

Abstract: In this paper, we deal with a fleet of autonomous vehicles which is required to perform internal logistics tasks inside some protected areas. This fleet is supposed to be ruled by a hierarchical supervision architecture which, at the top level, distributes and schedules Pick up and Delivery tasks, and, at the lowest level, ensures safety at the crossroads and controls the trajectories. We focus here on the top level and deals with the problem which consist in inserting an additional vehicle into the current fleet and routing it while introducing a time dependent estimation of the risk induced by the traversal of any arc at a given time. We propose a model and design a bi-level heuristic and an A*-like heuristic which both rely on a reinforcement learning scheme in order to route and schedule this vehicles according to a well-fitted compromise between speed and risk.

Complete Paper #48

Addressing the Challenges of Last-mile: The Drone Routing Problem with Shared Fulfillment Centers

Maria Bruni and Sara Khodaparasti

Department of Mechanical, Energy and Management Engineering, University of Calabria, Rende, Cosenza, Italy

Keywords: Drone Routing Problem, Drone Energy Consumption, Uncertainty.

Abstract: With the easing of restrictions worldwide, drones will become a preferred transportation mode for last-mile deliveries in the coming years. Drones offer, in fact, an optimal solution for many challenges faced with last-mile delivery as congestion and emissions and can streamline the last leg of the supply chain. Despite the common conviction that drones will reshape the future of deliveries, numerous hurdles prevent practical implementation of this futuristic vision, among which the limited drone range and payload. To overcome this issue, big companies such as Amazon, are already filing up patents for the development of fulfilment centers where drones can be restocked before flying out again for another delivery, effectively extending their range. Only a few authors have addressed the joint problem of operating these facilities and providing services to retail companies. This paper addresses this problem and proposes a mathematical formulation to show the viability of the proposed approach.

Complete Paper #39

Management of Groups of Passengers on Buses Considering the Restrictions of COVID-19

Francesca Guerriero, Martina Luzzi and Giusy Macrina

Department of Mechanical, Energy and Management Engineering, University of Calabria, Italy

Keywords: COVID-19, Social Distancing, Passenger Transportation, Group Seat Assignment Problem.

Abstract: During the epidemiological emergency, the measures adopted by the governments to contain the spread of the virus have caused heavy changes in the passenger transportation sector. In this work, we address the problem of managing groups of passengers on buses considering COVID-19-related restrictions. We propose a linear integer programming model to represent mathematically the bus group assignment problem, whose main aim is to make the best seat-passenger assignment, in such a way that the social distancing constraints, imposed for containing the spread of COVID-19, are satisfied. The developed formulation, accordingly to the current Italian rules, considers not only the physical distancing among passengers, but also the possibility to allocate household groups close to one another. The proposed model is tested empirically considering a real case study of a bus company operating in Italy. The computational results reveal that our model could help the transportation company to effectively manage the capacity, improve customer service, and maintain the social distancing in order to prevent the risk of contagion, by maximizing the revenue.

Thursday, 3

Friday Sessions: February 4

Friday Sessions: February 4 Program Layout

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9:30		ICORES Session 4		
10:00		#1, #29, #44		
10:30				ICORES Poster Session 1
11:00				
11:30				
12:00	ICORES Session 5	ICORES Session 5		
12:30	#4, #22, #46	#11, #18, #23, #45		
13:00				
13:30				
14:00				
14:30			Keynote Lecture	
15:00			David Ríos Insúa	
15:30				
16:00		ICORES Session 6		
16:30		#6, #14, #16, #50, #54		
17:00				
17:30				
18:00				

Complete Paper #1

An Efficient Relax-and-Solve Algorithm for the Resource-Constrained Project Scheduling Problem

Alireza Etminaniesfahani, Hanyu Gu and Amir Salehipour

School of Mathematical and Physical Sciences, University of Technology Sydney, Australia

Keywords: Relax-and-Solve, Project Scheduling, Resource-Constrained Project Scheduling Problem, RCPSP, Makespan, Matheuristic.

Abstract: The resource-constrained project scheduling problem (RCPSP) has a broad range of practical applications, e.g., in manufacturing, mining, and supply chain, among others(Kreter et al., 2015). Over the last 50 years, many researchers have tried to solve this challenging NP-hard problem. This paper presents an efficient and easy-to-implement relax-and-solve matheuristic to solve RCPSP. The proposed method employs constraint programming in a heuristic framework and uses CPLEX as an optimization solver. This algorithm is tested on more than 1500 instances from the standard library PSPLIB. Our experimental results show that the proposed heuristic framework outperforms the CPLEX and provides competitive results compared with the state-of-the-art techniques.

Complete Paper #29

A Zero-blockage based Scheduling for Import Containers Pickup Operations at Container Terminal Yards

Ahmed Azab and Hiroshi Morita

Department of Information and Physical Sciences, Graduate School of Information Science and Technology, Osaka University, Suita, Japan

Keywords: Truck Appointment Scheduling, Container Terminals, Stacking Sequence.

Abstract: In container terminals (CTs), containers are stacked above each other due to the limited yard area space used for storing the containers. External trucks usually submit appointment requests to pick up their import containers from the CT. However, some containers are not on the top stack and are blocked by other containers when trucks arrive at the terminal yard. Resolving this blockage requires relocating all containers above the targeted container. This non-value-added operation reduces the yard crane utilization and increases the service of external trucks. This paper studies the appointment scheduling for picking up containers, considering the container stacking sequence in the yard. We propose a scheduling method for container pickup appointments to avoid container blockages. An IP model is developed to minimize shifting appointment times for picking up import containers from its preferable pickup time windows. The performance of the developed model is investigated by solving some numerical instances. In addition, further analyses are performed to study the effect of container blocking on appointment scheduling.

Complete Paper #44

Incremental Scheduling of the Time-triggered Traffic on TTEthernet Network

Zdeněk Hanzálek and Jan Dvořák

CIIRC, Czech Technical University in Prague, Jugoslavskych partyzanu 1580/3, Prague, Czech Republic

Keywords: Scheduling, Ethernet, Time-triggered.

Abstract: Complex systems are often developed incrementally when subsequent models must be backward compatible with the original ones. The need to exchange high-volume data, for example, multimedia streams in the avionic systems, together with safety-critical data, puts demands on both the high bandwidth and the deterministic behavior of the communication. TTEthernet is an Ethernet based protocol that enables the transmission of the time-triggered messages. Thus, synthesizing a good schedule that meets all the deadline requirements and preserves the backward compatibility with the schedules of preceding models is essential for the performance of the whole system. In this paper, we study the problem of designing periodic communication schedules for time-triggered traffic. The aim is to maximize the uninterrupted gap for the remaining non-deadline-constrained traffic. The provided scheduling algorithm, based on MILP and CP formulation, can obtain good schedules in a reasonable time while preserving the backward compatibility. The experimental results show that the time demands of the algorithm grows exponentially with the number of messages to be transmitted, but, even for industrial-sized instances with more than 2000 messages, the algorithm is able to return the close optimal schedules in the order of hundreds of seconds.

Abstract #9

Introduction to Freshness Ratio of Information

Yutae Lee

Republic of Korea

Keywords: Freshness Ratio of Information, Age of Information, Queueing Model.

Abstract: Age of Information (AoI) measures how fresh information is. The AoI refers to the amount of time that has elapsed since the generation of the most recently successfully received message. In this abstract, we explain some conventional AoI metrics and introduce anther metric, Freshness Ratio of Information (FRoI).
The metrics related to AoI include average AoI and peak AoI. Average AoI means the time average of AoI and peak AoI means the peak value of AoI. The peak AoI corresponds to the AoI immediately before the information is updated. Consider a case where the freshness of information needs to be kept below a threshold. Average AoI alone cannot determine how much AoI is below the threshold. Peak AoI is sometimes inefficient because it only considers the peak values and not the time interval between peaks.
The FRoI is defined to be the fraction of time the age does not exceed a predefined freshness threshold. We are interested in high FRoI in order to maintain fresh information. The FRoI can be utilized in time-critical applications where we need to apply a threshold restriction on AoI.

Friday, 4

Complete Paper #5

An Analysis and Design for the Repair Process of Late Show Shipments in the Export Cargo Process at SPL HUB

Sjoerd van Rooden[1], Catya Zuniga[1], Bart Krol[2] and Elias Olivares-Benitez[3]

[1] *Faculty of Technology, Amsterdam University of Applied Sciences, Weesperzijde 190, Amsterdam, The Netherlands*

[2] *KLM Cargo, Schiphol, The Netherlands*

[3] *Facultad de Ingenieria, Universidad Panamericana, Zapopan, Mexico*

Keywords: Late Shipments, Late Shows, Repair Process, Acceptance Process, Business Process Modelling, Air Cargo Operations.

Abstract: Export shipments arriving late at the freight building of KLM Cargo at Schiphol Airport is a trigger to deviations in the standard acceptance process. These Late Shows are currently handled ad-hoc making it difficult to plan and predict these events. By conducting a data analysis to quantitatively identify the characteristics of the Late Shows, and by conducting stakeholder interviews to understand the current process and discuss the future process, this research tried to design the operational process of the Late Shows to improve the operational excellence and quality of the acceptance process. The research shows that currently, late shipments are often still tried to be build up for the planned flight. It is found that 13% of these shipments do eventually not depart on the planned flight. The research concludes that the design of the Late Show process should include a check on whether the shipment was delivered on time, before acceptance of the shipment. By only accepting the shipment once it is decided that the planned flight is achievable or when it is rebooked to another flight, it is assured that the Late Show will be on time at the build-up buffer for the booked flight.

Complete Paper #7

Project Ranking with Uncertainty using Multicriteria Decision Method and Fuzzy

Guilherme Marcondes

National Institute of Telecommunications, Inatel, Av. Joao de Camargo, 510, Santa Rita do Sapucai, Brazil

Keywords: Project Selection, Multicriteria Decision Methods, TOPSIS, Uncertainty, Fuzzy.

Abstract: Decision-makers are frequently faced with the task of picking projects to be carried out. Generally, there aren't enough resources to fund all of them. Because numerous criteria to be examined at the same time in this task, decision requires the assistance of a tool or approach. Multi-Criteria Decision-Making strategies can be helpful. However, as with all project estimation, uncertainty must be addressed. Using the TOPSIS method and fuzzy numbers, this article presents a way for incorporating uncertainty in project selection. It is exemplified by the application of selection method over a set of 11 real projects.

Complete Paper #11

Online Heuristic Approach for Efficient Allocation of Limited COVID-19 Testing Kits

Muhammad Alfas and Shaurya Shriyam

Department of Mechanical Engineering, Indian Institute of Technology, Delhi, India

Keywords: COVID-19 Testing, Resource Management, Pooled Testing, Multi-armed Bandit, Online Dynamic Allocation.

Abstract: Testing kit scarcity plays an important role in aggravating any epidemiological response against pandemics such as COVID-19, especially for resource-constrained countries. Better decision-making tools are essential to assist policymakers in containing the disease from spreading to a large extent despite limited resource availability. We propose a testing kit allocation framework that comprises three components: estimation of time-varying prevalence rates using empirical Bayes model, testing kit allocation using multi-armed bandit algorithms, and pooled testing technique to extract the maximum utility from the available testing kits. We conduct simulation experiments based on real-world data and obtain results to demonstrate the enhanced efficiency in detecting COVID-19 cases. We conclude that Bayesian estimation of prevalence coupled with bandit-based allocation performs significantly well. We also identify scenarios under which pooled testing offers a strong advantage.

Complete Paper #28

On the Local Dominance Properties in Single Machine Scheduling Problems

Natalia Jorquera-Bravo[1,2] and Óscar C. Vásquez[1,2]

[1] *University of Santiago of Chile (USACH), Faculty of Engineering, Program for the Development of Sustainable Production Systems (PDSPS), Santiago, Chile*

[2] *University of Santiago of Chile (USACH), Faculty of Engineering, Department of Industrial Engineering, Santiago, Chile*

Keywords: Single Machine Scheduling Problem, Local Dominance Properties, Search Space, Computational Complexity.

Abstract: We consider a non-preemptive single machine scheduling problem for a non-negative penalty function f. For this problem every job j has a priority weight w_j and a processing time p_j, and the goal is to find an order on the given jobs that minimizes $\sum w_j f(C_j)$, where C_j is the completion time of job j. This paper explores the local dominance properties in this problem, which provide a powerful theoretical tool to better describe the structure of optimal solutions by identifying rules that at least one optimal solution must satisfy, reducing the search space from $n!$ to $n!/3^{n/3}$ schedules and providing insights to show the computational complexity status for problem with a convex penalty from a general framework, such as the problem of minimizing the sum of weighted mean squared deviation of the completion times with respect to a common due date and jobs with arbitrary weights.

Complete Paper #34

Stochastic Programming Model for Elective Surgery Planning: An Effect of Emergency Surgery

Ryota Akiyama, Mari Ito and Ryuta Hoshino

Department of Industrial Administration Faculty of Science and Technology, Tokyo University of Science, 2641 Yamazaki, Noda, Chiba 278-8510, Japan

Keywords: Stochastic Programming, Emergency Surgery, Surgery Planning, Operating Room.

Abstract: This paper introduces a stochastic programming model for a hospital with two surgery types: elective and emergency surgeries. We propose a model that decides the number of the elective surgeries per day according to a scheme that makes best use of the operating rooms. Specifically, we model when the demand capacity for emergency surgery in the operating room of one day is uncertain. We created multiple surgery times, performed random sampling, and conducted numerical experiments. In the results, emergency surgery changed the allocation of elective surgery. In this paper, we report on the proposed model and numerical results, and discuss these and the future research prospects.

Complete Paper #38

Is Ignorance a Bliss in Sustainability? Evaluating the Perceptions of Logistics Companies' Self-Assessment in Environmental Performance

Oskari Lähdeaho and Jyri Vilko

LUT University, Tykkitie 1, Kouvola, Finland

Keywords: Logistics, Environmental Sustainability, Performance Measurement, Case Study.

Abstract: Effective management of any company relies on awareness of surroundings and ability to appropriately measure and control the operations. As sustainability issues have emerged as central concern in societies, companies are also aiming to improve their performance in this regard. Therefore, sustainability related measurements are required for companies looking to manage their sustainability. Qualitative multiple case study data reveals some inconsistencies between companies' environmental performance and associated self-evaluation and reporting. The case studies are analyzed with focus on management capabilities in informed environmental sustainability related decision-making. It seems that companies are eager to take first steps towards environmental sustainability. However, overconfidence from initial successes can hinder further advances in environmental sustainability. Cognitive capabilities in self-evaluation seem to have implications for organizations in addition to individuals. While vital for advances in environmental sustainability, improvements should be reflected with critical view to avoid false sense of security. Companies' environmental communications are often overexaggerated due to illusory superiority. Self-awareness in context of companies' environmental performance should be further studied.

Complete Paper #55

Comparative Analysis of Heuristic Approaches to $P||C_{max}$

Dragutin Ostojić[1], Tatjana Davidović[2], Tatjana Jakšić Krüger[2] and Dušan Ramljak[3]

[1] *Faculty of Science, Department of Mathematics and Informatics, University of Kragujevac, Serbia*

[2] *Mathematical Institute, Serbian Academy of Sciences and Arts, Belgrade, Serbia*

[3] *School of Professional Graduate Studies at Great Valley, The Pennsylvania State University, Malvern, PA, U.S.A.*

Keywords: Scheduling Problems, Identical Processors, Stochastic Heuristics, Solution Transformation.

Abstract: Cloud computing, new paradigms like fog, edge computing, require revisiting scheduling and resource allocation problems. Static scheduling of independent tasks on identical processors, one of the simplest scheduling problems, has regained importance and we aim to find stochastic iterative heuristic algorithms to efficiently deal with it. Combining various actions to define solution transformations to improve solution quality, we created 35 heuristic algorithms. To investigate the performance of the proposed approaches, extensive numerical experiments are performed on hard benchmark instances. Among the tested variants, we identified the best performing ones with respect to the solution quality, running time, and stability.

Session 5A	ICORES
11:45 - 13:15	Room 8
Innovative Methods in OR	

Abstract #11

An Evolutionary Computation Method for Initial Step Length Selection to Improve Run Time of a Line Search Optimization Algorithm

Prashant Prakash Deshpande

Freelancer, 8 Trimurti Darshan, Near Subhash Dairy, Gandhinagar, Dombivli East, India

Keywords: Evolutionary Computation, Step Length, Line Search, Optimization.

Abstract: Line search algorithms typically employ fairly simplistic strategies for initial step length selection that is subsequently improved upon such that it satisfies Wolfe conditions. We think evolutionary computation will help especially if the user of the algorithm is naïve about the mathematical properties of the function and as a result chooses the seed solution for the algorithm at a fair distance from the optima. We think this is not all that a bad assumption to have in software development research especially in the applied sciences. We report improved strategy performance for the Booth function.

Literature Review
An unconstrained optimization algorithm popularly uses the iterative Line Search algorithm which sets a starting point for the step length and subsequently computes one that satisfies Wolfe conditions. A successful program converges with a pre-fixed tolerance. A popular strategy in Nocedal and Wright (2006) hereafter referred to as NW uses steepest descent, is easy to implement and is fairly intuitive: InitialStepLength(iteration) = WolfeStepLength(iteration-1)*Gradient(iteration-1)*UnitDescent(iteration-1)/ Gradient(iteration)*UnitDescent(iteration). This strategy is hereafter

Friday, 4

referred to as S1. Another algorithm in NW hereafter referred to as A1 chooses 0 as the starting step length for each iteration. We use a combination of both the strategies to improve run time.

Our Proposed Algorithm Strategy
Only for the first iteration we use A1's initial step length. For subsequent iterations we use a modified version of S1. We bracket the computation of the step length within a bracket and draw values from this bracket that will satisfy Wolfe conditions. For the first iteration, we begin with an initial step length of zero, compute the step length that satisfies Wolfe conditions and modify it using a seed multiplier to estimate an initial step length for the next iteration. Based on the step length computed in the next iteration we revise the multiplier either upwards or downwards using evolutionary computation.

Results and Conclusion
We use the 2-dimensional Booth function to test our algorithm's performance. The minimizer of the function is (1,3) and $f(1,3) = 0 : f(x,y) = (x + 2y - 7)^2 + (2x + y - 5)^2$. A cursory look at the function makes it evident that the function reaches its minimum value when the expressions within the bracket are set to 0 and solved simultaneously. We chose this function because users typically treat the optimization algorithm as a black box that pops out a solution and even such cursory observations are routinely not made. Our algorithm converges in 18 iterations and improves upon A1 which converges in 23 iterations but we report a higher error of 0.58% vs A1's 0.34%. The S1 algorithm doesn't converge even after 50 iterations. We choose the seed solution at (7,9) to demonstrate the power of our algorithm. Going forward, we will look to improve run time further using advanced numerical linear algebra as we implement the algorithm in a professional software.

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Complete Paper #18

Prognostic-based Maintenance Optimization in Complex Systems with Resource Limitation Constraints

Junkai He[1], Miguel Anjos[2], Makhlouf Hadji[1] and Selma Khebbache[1]

[1] Technological Research Institute SystemX, 8 Avenue de la Vauve, 91120 Palaiseau, France

[2] School of Mathematics, University of Edinburgh, Peter Guthrie Tait Road, Edinburgh EH9 3FD, Scotland, U.K.

Keywords: Predictive Maintenance, Optimization, Complex System, Prognostic Information, Remaining Useful Life, Resource Limitation.

Abstract: This paper is concerned with prognostic information for maintenance optimization in complex systems. At each stage of such a system, we consider redundant components used as backup to guarantee the system's availability. The Remaining Useful Life (RUL/prognostic information) of components is used to evaluate each component's redundancy. We address RUL-based maintenance optimization under resource limitation to ensure the availability of the system such that production demands can be satisfied in a given maintenance planning horizon. We propose a mixed-integer linear programming approach to minimize the overall cost. Our numerical results on test instances show the

efficiency of the proposed approach to attain optimal solutions.

Complete Paper #23

Modelling Influence of Motivation on Efficient Tasks Distribution for Given Team-project Correspondence

Valentina Guleva, Egor Shikov and Klavdia Bochenina

National Center for Cognitive Research, ITMO University, Kronverkskii Prospect 49, Saint-Petersburg, Russian Federation

Keywords: Mathematical Model, Agent-based Model, Personal Productivity, Motivation, Competence, Simulation, Task Assignment, Project Management.

Abstract: The mathematical model of project execution, considering motivation effects on personal productivity is suggested in the paper. The main supposed application of the model is the task allocation problem during project management, which is restricted by the parameters of correspondence between tasks and team competence and interests, and execution deadline restrictions. In this way, motivation is considered an influential factor, and we explore how it affects team productivity and how can it be managed by task allocation strategies on the basis of personal motivation control. Namely, we explore the effects of personal motivation factors on overall project success. For this purpose, we consider motivation and competence factors in the model at the agent level, and take into account the initial abilities of a team, with given competence and motivation, to implement a project requiring a number of skills. To measure the effect of motivation and its role in project management, we perform a set of experiments showing (i) optimistic project execution times on the basis of team abilities against project requirements, (ii) possible effects of motivation on project execution and possibilities of its management, and (iii) effects of managerial approaches on team productivity (competence and motivational growth and their effects on tasks execution). The results show that poor correspondence between team and project competencies and interests can tenfold decrease team productivity, which can be partly eliminated by task assignment strategies, aimed at motivation control.

Complete Paper #45

A Bibliometric Review and Visualization Analysis in Product Development Project Management: 2012-2021

Pingye Tian, Qing Yang and Yingxin Bi

School of Economics and Management, University of Science & Technology Beijing, China

Keywords: Product Development Project, CiteSpace, Research Hotspots, Visual Analysis.

Abstract: CiteSpace is used to do the visualization analysis to all the product development project literature collected in SCI-E and SSCI, with which time and space distribution, collaborative network of authors, collaborative network of institutions, co-cited journal, co-occurrence keyword knowledge maps are made to reveal the space distribution, hot topics and development trends in the field of product development project. The study results show that: American, Germany and British scholars have led this field, some Chinese scholars also produce lots of results. Hot topics includes the performance and success factors of product development, innovation management, system modelling and knowledge management of development organization. The result can promote theoretical development of the product development, which will help scholars to determine trends and direction. This

paper also provides guidance and reference for firms to achieve good practice in product development.

Session 5B	ICORES
11:45 - 13:15	Room 7
OR in Transportation & Routing	

Complete Paper #4

Optimal 1-Request Insertion for the Pickup and Delivery Problem with Transfers and Time Horizon

José-L. Figueroa, Alain Quilliot, Hélène Toussaint and Annegret Wagler

LIMOS INP, Université Clermont Auvergne, France

Keywords: Pickup and Delivery Problem with Transfers, 1-Request Exact Insertion, Constrained Shortest Path, Constraint Propagation, Time Expanded Networks.

Abstract: In this paper, we deal with a subproblem of the Pickup and Delivery Problem with Transfers (PDPT) where a finite set of transportation requests has been assigned to a homogeneous fleet of limited capacity vehicles, while satisfying some constraints imposed by a set of pre-scheduled tours. Then, a new transportation request appears, and we also have to serve it. For that, we can modify the current tours by performing a finite sequence of changes allowing to pick up, transport, transfer or deliver this new request. The resulting tours must serve all the requests and satisfy the original constraints, but within a given time horizon. To solve this problem, we present an empirical Dijkstra algorithm that computes tentative solutions whose consistence is checked through constraint propagation, and an exact algorithm which is an adaptation of the well-known A* algorithm for robot planning, that performs an exhaustive search in a tree of partial solutions and reduces the combinatorial explosion by pruning some unfeasible/redundant tree nodes. We conclude by comparing the performance of both algorithms.

Complete Paper #46

On Finding k Earliest Arrival Time Journeys in Public Transit Networks

Ali Al-Zoobi[1], David Coudert[1], Arthur Finkelstein[2] and Jean-Charles Régin[1]

[1] *Université Côte d'Azur, Inria, CNRS, I3S, Sophia Antipolis, France*
[2] *Instant System, Sophia Antipolis, France*

Keywords: Public Transit Routing, Shortest Path, Dissimilar Paths.

Abstract: Journey planning in (schedule-based) public transit networks has attracted interest from researchers in the last decade. In particular, many algorithms aiming at efficiently answering queries of journey planning have been proposed. However, most of the proposed methods give the user a single or a limited number of journeys in practice, which is undesirable in a transportation context. In this paper, we consider the problem of finding k earliest arrival time journeys in public transit networks from a given origin to a given destination, i.e., an earliest arrival journey from the origin to the destination, a second earliest arrival journey, etc. until the kth earliest arrival journey. For this purpose, we propose an algorithm, denoted by Yen - Public Transit (Y-PT), which extends to public transit networks the algorithm proposed by Yen to find the top-k shortest simple paths in a graph.

Moreover, we propose a more refined algorithm, called Postponed Yen - Public Transit (PY-PT), enabling a considerable speed up in practice. Our experiments on several public transit networks show that, in practice, PY-PT is faster than Y-PT by an order of magnitude.

Complete Paper #22

Analysis of Computational Efficiency in Iterative Order Batching Optimization

Johan Oxenstierna[1,2], Jacek Malec[1] and Volker Krueger[1]

[1] *Dept. of Computer Science, Lund University, Lund, Sweden*
[2] *Kairos Logic AB, Lund, Sweden*

Keywords: Order Picking, Order Batching Problem, Computational Efficiency, Warehousing.

Abstract: Order Picking in warehouses is often optimized through a method known as Order Batching, wherein several orders can be assigned to be picked by the same vehicle. Although there exists a rich body of research on Order Batching optimization, one area which demands more attention is that of computational efficiency, especially for warehouses with unconventional layouts and vehicle capacity configurations. Due to the NP-hard nature of Order Batching, computational cost for optimally solving large instances is often prohibitive. In this paper we focus on approximate optimization and study the rate of improvement over a baseline solution until a timeout, using the Single Batch Iterated (SBI) algorithm. Modifications to the algorithm, trading computational efficiency against increased memory usage, are tested and discussed. Existing and newly generated benchmark datasets are used to evaluate the algorithm on various scenarios. On smaller instances we corroborate previous findings that results within a few percentage points of optimality are obtainable at minimal CPU-time. For larger instances we find that solution improvement continues throughout the allotted time but at a rate which is difficult to justify in many operational scenarios. The relevance of the results within Industry 4.0 era warehouse operations is discussed.

Keynote Lecture	ICORES
14:30 - 15:30	Room Plenary 1

Operations Research Opportunities in Automated Driving Systems

David Ríos Insúa

ICMAT, Spain

Abstract: Automated driving systems (ADS) will redefine human transportation. Due to recent breakthroughs in artificial intelligence and computational processing, mass public transportation via autonomous vehicles is no longer in our distant future. However, the transition from current roadways to fully automated roadways will not be instantaneous. This opens up many interesting research opportunities in OR and DS some of which I shall discuss in the talk: ethical decisions in ADS, request to intervene decision support and multiagent decisions in ADS.

Friday, 4

Session 6A
15:45 - 17:45
Linear Programming

ICORES
Room 8

Complete Paper #6

Solver-based Approaches for Robust Multi-index Selection Problems with Stochastic Workloads and Reconfiguration Costs

Marcel Weisgut, Leonardo Hübscher, Oliver Nordemann and Rainer Schlosser

Hasso Plattner Institute, University of Potsdam, Potsdam, Germany

Keywords: Resource Allocation Problems, Stochastic Workloads, Index Selection, Robustness, Linear Programming.

Abstract: Fast processing of database queries is a primary goal of database systems. Indexes are a crucial means for the physical design to reduce the execution times of database queries significantly. Therefore, it is of great interest to determine an efficient selection of indexes for a database management system (DBMS). However, as indexes cause additional memory consumption and the storage capacity of databases is limited, index selection problems are highly challenging. In this paper, we consider a basic index selection problem and address additional features, such as (i) multiple potential workloads, (ii) different risk-averse objectives, (iii) multi-index configurations, and (iv) reconfiguration costs. For the different problem extensions, we propose specific model formulations, which can be solved efficiently using solver-based solution techniques. The applicability of our concepts is demonstrated using reproducible synthetic datasets.

Complete Paper #50

Multi-periodic Joint Replenishment Planning Method for Various All-unit Discounts

Agathe Métaireau[1,2], Rabin Sahu[1], Simon Delecourt[1], Alexandre Gerussi[1] and Manuel Davy[1]

[1] *Vekia, 143 rue d'Athènes, Lille, France*
[2] *Univ. Lille, CNRS, Centrale Lille, UMR 9189 - CRIStAL, France*

Keywords: Joint Replenishment, Multi-period Planning, Inventory Control, Integer Linear Programming.

Abstract: This paper aims at developing a multiperiodic joint replenishment optimization method to tackle all-unit discounts. In many industrial contexts, there exist multi-item constraints that can't be treated by single-item optimization. For example, suppliers can charge a fixed ordering cost or offer a discount above a given ordered quantity. To tackle such constraints, we set in place a model based on ordering blocks. This modeling enables to reduce the search-space by predetermining a given set of possible order quantities. The model is then solved using an Integer Linear Program that outputs the ordering plan for a given time horizon. This Integer Linear Program searches for the ordering block combination that gives the minimal cost. The cost function includes single-item costs like purchase or inventory costs as well as multi-item costs. The methodology was tested on twenty generated instances and compared with a single-period single-item replenishment engine. We show that our multiperiodic joint replenishment approach allows a reduction of the costs and an increase in the service level.

Complete Paper #54

Two-phase Kernel Search: An Application to Facility Location Problems with Incompatibilities

Renata Mansini and Roberto Zanotti

Department of Information Engineering, University of Brescia, Italy

Keywords: Single-source Capacitated Facility Location Problem, Multi-source Capacitated Facility Location Problem, Incompatibilities, Kernel Search.

Abstract: Among the most important variants of the capacitated facility location problem are those introducing side constraints. In the present paper, we analyze the introduction of incompatibility constraints in the single- and multi-source capacitated facility location problems. We deal with two different types of conflict that concern: (i) the incompatibility among customers when jointly served by the same facility and (ii) the conflict among facilities. We study their mathematical formulations and solve them by means of a two-phase variant of the general-purpose framework Kernel Search. The method, evaluated on benchmark instances, shows to be extremely effective getting better results than Gurobi when solving the models with a time limit of one hour. Interesting managerial insights are also drawn on optimal solutions, when available.

Complete Paper #14

Optimizing Route Planning for Minimising the Non-added-Value Tasks Times: A Simultaneous Pickup-and-Delivery Problem

Bárbara Romeira[1] and Ana Moura[1,2]

[1] *Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Aveiro, Portugal*
[2] *GOVCOPP – Systems for Decision Support Research Group, University of Aveiro, Portugal*

Keywords: Vehicle Routing Problem, Simultaneous Delivery and Pickup, Time Windows, Automotive Industry, Mathematical Integer Linear Programming Model.

Abstract: The quick-change industrial environment pushes organisations to find new ways to improve efficiency, flexibility, and responsiveness. To do so, companies must not solely focus on improving the main value chain, but also the support services that provide for it. To this end, this paper focuses on a route optimization study, inspired by a real-case problem of the Manufacturing Tool Repair Service, from an automotive company. The problem consists of a vehicle routing problem with simultaneous delivery and pickup and time windows, subjected to specific service constraints. To solve it, we propose a Mathematical-Integer Linear Programming model, which is triggered by real-time data from the shopfloor. The approach was tested, and the results show an average of 30% improvement compared with the current situation. Additionally, the model was tested using modified benchmark instances and a time windows sensitivity analysis was performed. Considering the results obtained, future work regarding the application of a hybrid algorithm is proposed

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Complete Paper #16

Designing a New Layout for a Balanced Production Line: A Practical Application

Marlene Brás[1] and Ana Moura[1,2]

[1] *Department of Economics, Management, Industrial Engineering and Tourism, University of Aveiro, Portugal*
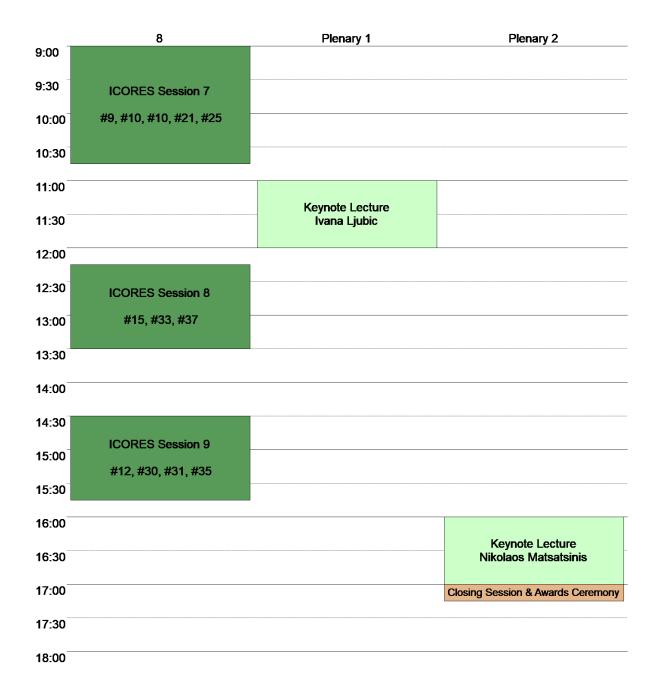
[2] *GOVCOPP – Systems for Decision Support Research Group, University of Aveiro, Portugal*

Keywords: Layout Design, Assembly Line Balancing, Systematic Layout Planning, Linear Programming.

Abstract: In most manufacturing companies, the layout designs and line balancing problems are often based on personal experience and made without following a theoretical methodology. By applying those ad-hoc solutions, various problems may arise when quick changes of capacity or any other constraints occur. This work was developed for a Portuguese SME in the electronics industry, that had some changes at the production level, which caused limitations in terms of space on the factory floor. Furthermore, it was also revealed that an existing production line with high production rates was gradually losing efficiency. Bringing these two issues together, the idea was to design a new plant layout to improve the performance of this production line, considering the new space constraints. To increase the production line efficiency, decisions such as the number of workers and assembly task assignment to stations need to be optimized to increase its throughput and decrease cost. An integer linear programming model was developed and used to solve the balancing problem. Considering six different optimization criteria, five variants of the model were tested. Using the best solution according to predefined Key Indicators Performance, the layout was developed using the Systematic Layout Planning approach.

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Saturday Sessions: February 5

Saturday Sessions: February 5 Program Layout

	8	Plenary 1	Plenary 2
9:00			
9:30	ICORES Session 7		
10:00	#9, #10, #10, #21, #25		
10:30			
11:00		Keynote Lecture	
11:30		Ivana Ljubic	
12:00			
12:30	ICORES Session 8		
13:00	#15, #33, #37		
13:30			
14:00			
14:30	ICORES Session 9		
15:00	#12, #30, #31, #35		
15:30			
16:00			Keynote Lecture
16:30			Nikolaos Matsatsinis
17:00			Closing Session & Awards Ceremony
17:30			
18:00			

Complete Paper #21

Outpatient Diversion using Real-time Length-of-Stay Predictions

Najiya Fatma and Varun Ramamohan

Department of Mechanical Engineering, Indian Institute of Technology Delhi, Delhi, India

Keywords: Length-of-stay, Patient Diversion, Delay Prediction, Primary Health Centers.

Abstract: In this work, we show how real-time length-of-stay (LOS) predictions can be used to divert outpatients from their assigned facility to other facilities with lesser congestion. We illustrate the implementation of this diversion mechanism for two primary health centers (PHCs), wherein we divert patients from their assigned PHC to the other PHC based on their predicted LOSs in both facilities. We develop a discrete-event simulation model of patient flow operations at these two PHCs in an Indian district and observe significantly longer LOSs at one of the PHCs due to disparities in the patient loads across both PHCs. We first determine the expected LOS of the patient at the point in time at which they are expected to arrive at a PHC using system state information recorded at the current time at the PHC in question. The real-time LOS predictions are generated by estimating patient wait times on a real-time basis at the queueing subsystems within the PHC. We then divert the patient to the appropriate PHC on the basis of the predicted LOS estimates at both PHCs, and show through simulation that the proposed framework leads to more equitable utilization of resources involved in provision of outpatient care.

Complete Paper #9

Performance Analysis for Threshold-based N-Systems with Heterogeneous Servers

Le Anh Thu[1] and Tuan Phung-Duc[2]

[1] *Public Policy Program, VNU Vietnam Japan University, My Dinh Campus, Nam Tu Liem, Hanoi,Vietnam*

[2] *Department of Policy and Planning Sciences, Faculty of Engineering, Information and Systems, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8573, Japan*

Keywords: Multi-skilled Servers, Threshold Policy, Matrix Analytic Method, Administrative Services.

Abstract: Driven by the need to develop methods for minimizing operational delays at public administration agencies, this paper considers problems involving routing and staffing in these agencies. We examine a threshold-based N-System of two queues with capacities $C_1 = \infty$ and $C_2 < \infty$, respectively. We use the matrix analytic method to obtain the steady-state probabilities, the performance measures, and the optimal threshold values in terms of the system parameters. Our numerical experiments reveal that the mean response time is sensitive to the stability condition, and the effectiveness of the threshold policy depends on the customer arrival rate.

Complete Paper #10

A Queueing Analysis of Multi-type Servers and Multi-type Customers System based on Gas Stations

Yoshito Machida[1] and Tuan Phung-Duc[2]

[1] *Graduate School of Science and Technology, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan*

[2] *Faculty of Engineering, Information and Systems, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan*

Keywords: Queueing Model, GI/M/1-type Markov Chain, Gas Station, Performance.

Abstract: Nowadays, cars are essential to life, and most cars used in society need refueling. In gas stations, an odd phenomenon often occurs where the server (refueling lane) is available, but the service is not available, and this is due to the mismatch between the type of the customer (car) and the type of the server. In this paper, we model some types of the system of gas stations as queueing models and analyze them. In addition, we derive performance measures and compare these types of systems. Some counter-intuitive results emerge in this study.

Abstract #10

Performance Evaluation for Remote Estimator of a Binary Markov Source

Yutae Lee

Republic of Korea

Keywords: Age of Information, Freshness Ratio of Information, Remote Estimator, Binary Markov Source.

Abstract: In several emerging networks and applications ranging from cyber-physical systems to timely data analysis, there has been a surge of interest in the freshness of information for real-time remote monitoring problems. When considering the freshness of information, traditional network performance metrics such as throughput and delay are not always effective. The Age of Information(AoI) metric has become a major research topic on real-time monitoring applications. However, recognizing the shortcomings of AoI, researchers have proposed several new metric of information freshness: for example, Age of Synchronization(AoS), Value of Information of Update(VoIU), Urgency of Information(UoI), Age of Incorrect Information(AoII), and Freshness Ratio of Information(FRoI). In the context of monitoring a binary information source over a delay system with feedback, we consider four different performance metrics: real-time error, AoI, AoII, and FRoI. For each performance metric, we model the delay system as a discrete-time Markov chain and evaluate the performance via stochastic analysis. Extensive numerical results are also provided to compare the four performance metrics under various system parameters.

Saturday, 5

Complete Paper #25

Queueing Model of Circular Demand Responsive Transportation System: Theoretical Solution and Heuristic Solution

Ayane Nakamura[1], Tuan Phung-Duc[1] and Hiroyasu Ando[2,3]

[1] *Graduate School of Science and Technology, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan*

[2] *Faculty of Engineering, Information and Systems, University of Tsukuba, Tsukuba, Ibaraki 305-8577, Japan*

[3] *Advanced Institute for Materials Research, Tohoku University, Sendai, Miyagi 980-8577, Japan*

Keywords: Queueing Model, Transportation, Ride-sharing, Heuristic Solution.

Abstract: Sharing mobilities, such as car-sharing and ride-sharing, have been widely spreading recently. In this paper, we consider Car/Ride-Share (CRS) system, which is one of the demand responsive transportations. We consider the scenario where CRS is introduced on the circular bus route. We propose its theoretical and heuristic solutions using queueing theory. We validate the heuristic analysis by comparing with the theoretical result through some numerical examples.

Keynote Lecture	ICORES
11:00 - 12:00	Room Plenary 1

A Tailored Benders Decomposition Approach for Last-mile Delivery with Autonomous Robots

Ivana Ljubic

ESSEC Business School of Paris, France

Abstract: This work addresses an operational problem of a logistics service provider that consists of finding an optimal route for a vehicle carrying customer parcels from a central depot to selected facilities, from where autonomous devices like robots are launched to perform last-mile deliveries. The objective is to minimize a tardiness indicator based on the customer delivery deadlines. We provide a better understanding of how three major tardiness indicators can be used to improve the quality of service by minimizing the maximum tardiness, the total tardiness, or the number of late deliveries. We study the problem complexity, devise a unifying Mixed Integer Programming formulation and propose an efficient branch-and-Benders-cut scheme to deal with instances of realistic size. Numerical results show that this novel Benders approach with a tailored combinatorial algorithm for generating Benders cuts largely outperforms all other alternatives. In our managerial study, we vary the number of available facilities, the coverage radius of autonomous robots and their speed, to assess their impact on the quality of service and environmental costs. Joint work with: L. Alfandari and M.M. de Silva

Session 8A	ICORES
12:15 - 13:30	**Room 8**
Industrial Engineering	

Complete Paper #15

Queueing Analysis and Nash Equilibria in an Unobservable Taxi-passenger System with Two Types of Passenger

Hung Nguyen[1] and Tuan Phung-Duc[2]

[1] *Graduate School of Science and Technology, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8573, Japan*

[2] *Faculty of Engineering, Information and Systems, University of Tsukuba, 1-1-1 Tennodai, Tsukuba, Ibaraki 305-8573, Japan*

Keywords: Queueing Theory, Markov Chain, Game Theory, Strategic Queueing, Taxi-passenger System.

Abstract: This paper considers an unobservable double-ended queueing system motivated by the application of a taxi station where passengers and taxis arrive at two sides of the queue, and there are two types of passengers, differentiated by their mean matching times with taxis. We use a three-dimensional Markov chain to model the system and derive several system performance measures (mean queue lengths, waiting times and social welfare). Furthermore, when agents are strategic, we model the system as a multi-population game among three populations of agents and find their joining rates in equilibrium.

Complete Paper #33

Assortment and Cut of Defective Stocks by Bilevel Programming

Claudio Arbib[1], Fabrizio Marinelli[2], Mustafa Pínar[3] and Andrea Pizzuti[2]

[1] *Dipartimento di Ingegneria/Scienze dell'Informazione e Matematica, Università degli Studi dell'Aquila, L'Aquila, Italy*

[2] *Dipartimento di Ingegneria dell'Informazione, Università Politecnica delle Marche, Ancona, Italy*

[3] *Department of Industrial Engineering, Bilkent University, Ankara, Turkey*

Keywords: Assortment Problem, Cutting Stock Problem, Defects, Bilevel Programming.

Abstract: In this paper we deal with the problem of deciding the best assortment and cut of defective bidimensional stocks. The problem, originating in a glass manufacturing process, can arise in various industrial contexts. We propose a novel bilevel programming approach describing a competition between two decision makers with contrasting objectives: one aims at fulfilling production requirements, the other at generating defects that, damaging the products, reduce yield as much as possible. By exploiting nice properties of adversarial optimal solutions, the bilevel program is rewritten as a one-level 0-1 linear program. Computational results achieved on random instances with realistic features are discussed, showing the quality and the benefits of the proposed approach in reducing the yield loss from defective material in a worst-case perspective.

Complete Paper #37

Forecasting Extractions in a Closed Loop Supply Chain of Spare Parts: An Industrial Case Study

Emna Turki[1,2], Oualid Jouini[1], Ziad Jemai[3], Laura Urie[2], Adnane Lazrak[2], Patrick Valot[2] and Robert Heidsieck[2]

[1] *Laboratoire Genie Industriel, CentraleSupélec, Université Paris-Saclay, 3 rue Joliot-Curie, 91190 Gif-sur-Yvette, France*

[2] *General Electric Healthcare, 283 Rue de la Minière, 78530 Buc, France*

[3] *Laboratoire OASIS, École Nationale d'Ingénieurs de Tunis, Université Tunis El Manar, BP37, 1002 Tunis, Tunisia*

Keywords: Healthcare Industry, Closed Loop Supply Chain, Spare Parts Harvesting, Intermittent Demand Forecasting.

Abstract: In healthcare industry, companies like GEHC (General Electric Healthcare) buy back their products at the EOL (End of Life) phase and reuse the spare parts composing them. This process is referred to as spare parts harvesting. The harvested parts are included in the spare parts supply chain which presents specific characteristics like the availability of critical parts and the intermittent demand behavior. Add to that, the unpredictability of the parts' supply capacity from bought back systems is a challenge for healthcare companies. The focus of this paper is to provide an accurate forecasting method of the harvested parts supply capacity for GEHC. To achieve this objective, a comparative study is carried out between statistical forecasting models. Then, a forecasting process employing the most accurate models is provided using TSB-Croston, the 12-month moving average, the best ARIMA model chosen with the Box-Jenkins methodology, and an introduced business knowledge based model. In order to improve the designed method accuracy, the statistical models' forecast is adjusted using contextual information. An error measurement based on a modified MAPE error is introduced to evaluate the forecast. By means of the designed method, the monthly accuracy is improved by 9%.

Session 9A	ICORES
14:30 - 15:45	Room 8
OR in Health Management	

Complete Paper #12

Optimal Models for Distributing Vaccines in a Pandemic

Md Hassan[1,2], Mahzabeen Emu[2], Zubair Fadlullah[1,2] and Salimur Choudhury[2]

[1] *Thunder Bay Regional Health Research Institute, Thunder Bay, Ontario, Canada*

[2] *Department of Computer Science, Lakehead University, Thunder Bay, Ontario, Canada*

Keywords: Pandemic, ILP, Vaccine Distribution, Operational Research, Policy Making.

Abstract: Distributing vaccines among a massive population is one of the challenging tasks in a pandemic. Therefore, health care organizations need to optimize the assignment of vaccination appointments for people while considering their priorities and preferences. In this paper, we propose two optimal vaccine distribution models as Integer Linear Programming (ILP) models; namely, Priority-based Model (PM) and Priority & Preference-based Model (PPM), to maximize the distribution of vaccines among a given population. In PM, we divide the people among several priority groups and ensure maximum vaccine distribution among the higher priority groups. However, along with the priority groups, PPM also considers a list of preferred vaccine distribution centers and time slots for each person. Thus, this model maximizes vaccine distribution among the higher priority groups by assigning appointments in their desired location and time. We analyzed the performance of our proposed models on a randomly generated dataset. In addition, we also performed a case study for our proposed models on the COVID-19 vaccination dataset from Thunder Bay, Canada. In both experiments, we show that PPM outperforms PM in full-filling people's preferences while maximizing the distribution of vaccines among the higher priority groups.

Complete Paper #30

Optimization of Emergency Medical Service with Fixed Centers

Marek Kvet

Faculty of Management Science and Informatics, University of Žilina, Slovakia Univerzitná 8215/1, 010 26 Žilina, Slovakia

Keywords: Location Analysis, Urgent Healthcare System, Service Accessibility Optimization, Radial Approach, Fixed Centers.

Abstract: The research reported in this scientific paper focuses on practical usage of optimization methods aimed at improving the service accessibility for clients spread over the whole Slovak Republic. The results of previous research confirmed by a computer simulation indicated that the weighted p-median problem is a suitable way of optimization. Here, we pay attention to the inconvenience of current ambulance stations deployment, which consists in the fact that there are same locations with two or more stations equipped with an ambulance vehicle. On the other hand, the standard weighted p-median problem formulation allows locating at most one station to one place. Furthermore, when searching for a better service center locations, the capacity of a center should be taken into account at least partially. Otherwise, the station with a high number of assigned clients would not be able to satisfy all the demands. Such result may be considered inacceptable. We believe that mentioned disadvantages could be overcome by fixing some stations, which will not be allowed to change their current location. The results of suggested optimization process are compared with the analysis of current ambulance stations deployment form more points of view.

Complete Paper #31

Real Life Pollution Measurement of Cairo

Youssef Khalil, Mariam Zaky, Mostafa ElHayani and Hassan Soubra

Media Engineering and Technology, German University in Cairo, Egypt

Keywords: ITS, AQI, Pollution, IoT, Machine Learning.

Abstract: Today, the cost associated to the significant growth in the transportation field is air and noise pollution. According to the World Health Organization (WHO), an estimate of seven million people worldwide die every year due to breathing bad quality air, in addition, morbidities such as high blood pressure, heart disease, sleep disturbances and stress might be linked to noise pollution. In this context, many researchers have done efforts in measuring air and noise pollution to be fully aware of the areas that have a negative impact on human health. In this paper an intelligent transportation system is proposed which uses a low-cost sensor device and a mobile application to monitor air pollution and noise pollution in Cairo, Egypt successively.

Saturday, 5

Complete Paper #35

A Multi-stage Integer Linear Programming Problem for Personnel and Patient Scheduling for a Therapy Centre

Georgia Fargetta and Laura Scrimali

University of Catania, Department of Mathematics and Computer Science, Via Andrea Doria, 6, 95125, Catania, Italy

Keywords: Personnel Scheduling, Assignment Problem, Mathematical Programming, Integer Programming.

Abstract: In this paper, we propose a multi-stage integer linear programming problem to solve the scheduling of speech-language pathologists involved in conventional treatments as well as in augmentative and alternative communication therapies. In order to reduce the complexity of this problem, we suggest a hierarchical approach that breaks the problem into three sub-problems: patient selection for augmentative and alternative communication therapies, therapists' shift assignment, and routing optimization of home-based rehabilitation services. The resulting models were tested on data collected in a physiotherapy centre in Acireale (Catania, Italy), using AMPL optimization package and Genetic Algorithm implemented in Matlab. From the results of the case study, the model ensures to maximize the number of patients eligible for augmentative and alternative communication therapies, to assign sustainable therapist schedule, and to optimize the home therapy routing.

Keynote Lecture	**ICORES**
16:00 - 17:00	**Room Plenary 2**

Intelligent Multi-Criteria Decision Support Systems

Nikolaos Matsatsinis

Technical University of Crete, Greece

Abstract: Multiple Criteria Decision Analysis/Making (MCDA/MCDM) is constantly increasing its presence in various scientific fields but also in new fields of its application. This expansion became possible mainly due to the integration and implementation of its methodologies in the Decision Support Systems (DSS). This enabled their successful applications in many new fields resulting in their further expansion as Multi-Criteria Decision Support Systems (MCDSS). Their combination with Artificial Intelligence (intelligent agents, recommender systems, expert systems) in general and especially in recent years with the field of Machine Learning and Data Mining has led to the development of Intelligent Multi-Criteria Decision Support Systems (IMCDSS) with enormous application in analytics. At the same time, MCDA was used to solve various problems and to develop new methodologies in the field of Machine Learning. The aim of this speech is to present on the one hand the theoretical issues and methodologies of the cooperation of the Multi-Criteria DSS with the Artificial Intelligence and on the other hand to present a series of such IMCDSS and their applications in various fields such as marketing, health, defense, agricultural, etc.

Closing Session & Awards Ceremony	**ICORES**
17:00 - 17:15	**Room Plenary 2**

Saturday, 5

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