Plenary Speakers

Research and practice impact in humanitarian operations: a critical review, challenges, and opportunities

Prof. Dr Maria Besiou

Plenary Speaker - Maria Besiou, Lecture Theatre, September 12, 2023, 11:15 - 12:15

Since the first publications on humanitarian operations, researchers have been concerned about the impact of our research. In this paper, we examine the impact of our field on academic research and on real-world practice, with an eye toward increasing impact. To that end, we review literature on measuring impact on research and practice, and draw out guidance to shape a series of analyses, including a review of papers in humanitarian operations and of topics in practitioner conferences and webinars, and a survey of the author community that identifies papers with impact on practice and research. We identify and compare the characteristics of papers that impact practice and those that impact research, and analyze the "recipes" for papers that impact both. We find limited but important examples of practice impact, and identify two key barriers preventing broader impact: limited connections between research and practice and the apparent difficulty of achieving both research and practice impact in one paper. Finally, we suggest ways to reach greater practice and academic impact.

Forty years of industry-university collaboration

Prof. Mauricio Resende

Plenary Speaker - Mauricio Resende, Lecture Theatre, September 13, 2023, 13:15 - 14:15

Biography:

Mauricio G. C. Resende is an Affiliate Professor of Industrial and Systems Engineering at the University of Washington. He grew up in Rio de Janeiro (BR), West Lafayette (IN-US), and Amherst (MA-US). He did his undergraduate training in electrical engineering (systems engineering concentration) at the Pontifical Catholic University of Rio de Janeiro. He obtained an MS in operations research from Georgia Tech and a PhD in operations research from the University of California, Berkeley.

He is most known for his work with metaheuristics, in particular GRASP (greedy randomized adaptive search procedures) and BRKGA (biased random-key genetic algorithms), as well as for his work with interior point methods for linear programming and network flows. Dr. Resende has published over 200 papers on optimization and holds 15 U.S. patents. He edited the Handbook of Heuristics (Springer, 2018), the Handbook of Optimization in Telecommunications (Springer, 2006), the Handbook of Massive Data Sets (Kluwer, 2002), and the Handbook of Applied Optimization (Oxford, 2002), and is coauthor of the book Optimization by GRASP (Springer, 2016).

He has a Google Scholar h-index of 83 and is on the List of Top 2% Scientists of the World (2020-21). He sits on the editorial boards of several optimization journals, including Networks, Discrete Optimization, J. of Global Optimization, and International Transactions in Operational Research. Dr. Resende is an INFORMS Fellow.

With a successful career spanning over four decades, Dr. Resende has brought his expertise to various industrial research laboratories worldwide. These include electrical power systems at Furnas Centrais Elétricas in Brazil, semiconductor device manufacturing at Fairchild Semiconductor Corporation in Silicon Valley, California, telecommunications at AT&T Bell Labs Research and AT&T Labs Research in New Jersey, and retail logistics at Amazon in Seattle. Dr. Resende's diverse professional experiences have established him as a leading figure in his field.

In this talk, I will weave the narrative of my four-decade-long odyssey bridging the spheres of academia and industry. Initiated during my doctoral studies at the University of California, Berkeley, my first collaboration intersected with researchers from Fairchild Semiconductors, exploring semiconductor fabrication through simulation, and partnered

with Narendra Karmarkar from AT&T Bell Labs, diving into the world of algorithm engineering of interior point methods for linear programming. The inception of GRASP and BRKGA will be discussed, their roots firmly planted in these interactions.

I will share insights from my tenure as a research scientist at renowned institutions such as Bell Labs Research during the '80s and '90s, AT&T Labs Research from 1996 to 2014, and at Amazon Research between 2014 and 2022. I will contrast my work experiences at these institutions.

Even though most of my professional life was spent within the confines of industrial research centers, I maintained robust interactions with academia worldwide, spanning continents from the Americas to Europe, Asia, and even the Russian Federation. In the process I supervised and
mentored numerous MSc and PhD students.

As we reach the final chapters of my narrative, we find my departure from Amazon in December 2022 and the beginning of a new journey as a visiting professor - a role that has guided me to this current moment, standing before you

Solving the proactive and reactive resource-constrained project scheduling problem

Erik Demeulemeester

Plenary Speaker - Erik Demeulemeester, Lecture Theatre, September 14, 2023, 13:30 - 14:30

During this talk, I will consider the proactive and reactive resource-constrained project scheduling problem in which the durations of project activities are characterized by uncertainty. Under such conditions, the baseline schedule that typically is constructed before project execution might not hold for a long time unless a lot of safety is built into the schedule. During the actual execution of a project, this baseline schedule may indeed suffer from disruptive events, causing the actually realized activity start times to deviate from the predicted baseline start times. This presentation focuses on robust project scheduling, in particular the development of effective and efficient proactive and reactive scheduling procedures. Proactive scheduling aims at generating robust baseline schedules that carry sufficient protection against any possible schedule disruptions that may occur during project execution. Reactive scheduling procedures aim at repairing the baseline schedule when the built-in protection fails during the execution of the project. We discuss the fundamentals of state of the art proactive/reactive project scheduling approaches and discuss key directions for future research.

Artificial Intelligence and Machine Learning

Explainable Reinforcement Learning: The missing link?

Dr Alex Green[1], Dr Jeremy Bradley[1]
[1]Datasparq

Parallel 1 - Artificial Intelligence and Machine Learning, Room 3.16, September 12, 2023, 09:15 - 10:45

Biography:
Jeremy Bradley is a Computer Scientist who moved to industry in 2015 to help set up Data Science teams at Tesco and Royal Mail. He now leads a team of 15 Data Scientists at Datasparq and is interested in furthering transfer of research into industrial products.

Alex Green is an astrophysicist by training and has worked in Data Science at Royal Mail and Datasparq on diverse projects from geospatial data science to optimisation. He has implemented reinforcement learning in several industrial settings for dynamic pricing and has a keen interest in explainability for industrial decisions.

Reinforcement learning is a hugely powerful technique in AI that mimics human learning. It differs from traditional supervised ML approaches in that it can respond to changes in its environment and learn new behaviours, decisions and strategies that are better adapted to the new environment.
Nonetheless constructing RL agents in industrial products - especially in the field of dynamic pricing - introduces huge challenges in explainability and trustworthiness and thus also adoption.
If these powerful AI tools are to be accepted and used in mission critical applications then we sometimes struggle to convince industry users of the provenance and believability of the decisions that an RL agent is recommending.
In conjunction with MSc students at Imperial College, we have started to understand what necessary explainability looks like in an RL setting, in order to get user understanding and buy-in.
Further to aid trust in the AI, we often have to implement so-called guard rails on the decisions that the RL agent generates. These guard rails give reasonable industrial bounds on the output to protect the business against unbounded exploration, whilst also maintaining the convergence guarantees that make RL so appealing as method.
We will talk about these guard rails and how they can generate unexpected behaviours that need to be looked for in a productionised tool.

Dynamic Personalised Modelling of Patient Pathways via Machine Learning and Markov processes

Dr` Edilson Arruda[1]
[1]University of Southampton

Parallel 1 - Artificial Intelligence and Machine Learning, Room 3.16, September 12, 2023, 09:15 - 10:45

Biography:
Edilson F. Arruda has a background in Electrical Engineering, with emphasis on Operational Research and Optimal Control. He has experience in the fields of Industrial Engineering and Management Science, with an emphasis on Operational Research problems under uncertainty. His research focuses on the application of Markov decision processes and stochastic modelling tools to challenging real-world problems with underlying uncertainties. It includes topics such as exact and approximate dynamic programming, reinforcement learning and stochastic optimal control, logistics and supply chain analytics and healthcare management.

Personalised healthcare is one of the new priorities of the NHS. To enable it, however, we need to understand how patient pathways vary at an individual level and across different lengths of time. This is by no means an easy task, as complex diagnostic and patient management pathways involve many sources of uncertainty. Responses will vary depending on the patient attributes; the environment; and the event, disease or intervention, under consideration. Furthermore, the same patient may respond differently to similar events under apparently similar conditions. We seek to model and understand this variation via the combination of Machine learning and stochastic modelling. Stochastic modelling will be used to understand the individual pathway progression over time, considering that the outcomes of interventions and treatments are stochastic even at the patient level. Machine learning, on the other hand, will help us build individualised stochastic models tailored for a given individual patient. Such a combination will give rise to realistic predictions that fully consider the uncertainties underpinning the evolution of the patient's health and help decision makers propose interventions whilst properly considering the variation of outcomes that can be expected over time. In contrast to the streamlined approach that characterises standardised clinical pathways, we propose an approach that will drive personalised clinical decisions at the patient level, whilst also providing the clinician with a broad view of the variations that may happen to that patient's pathway under each prescribed intervention. This will help decision makers design interventions to improve outcomes whilst contemplating the inevitable variation in patient pathways.

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Joint Credit and Profit Scoring: An Interpretable Decision Tree Model

Dr Huan Yu[1]
[1]University Of Southampton

Parallel 1 - Artificial Intelligence and Machine Learning, Room 3.16, September 12, 2023, 09:15 - 10:45

Biography:

Huan joined the Southampton Business School as a Lecturer in September 2019. Before joining the University of Southampton, Huan completed her PhD in Management Science and Engineering from the School of Management at the University of Science and Technology of China.

Traditionally, lenders rely on credit scoring and profit scoring models to manage their credit risk. Credit scoring is a predictive model to distinguish the default applicants while profit scoring models are developed to optimize the expected profit. Although the two scoring models are often used together to help financial institutions to make the loan-granting decision, they were proposed separately. In this study, we develop a novel decision tree model of joint credit and profit scoring. Instead of measuring loss of default prediction error, the proposed joint model considers the decision error of profitability induced by default prediction parameters. We demonstrate the proposed joint model improves the quality of loan-granting decision by conducting the analysis on the real credit dataset.

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A Two-step XGBoost Algorithm for Predicting Passenger Flight Load: A Case Study at Rotterdam the Hague Airport

Dr Hani Al-Ers[1], Mr. Hendrico Burger[1], Dr Mathis Mourey[1], Professor Lampros Stergioulas[1], Dr. Jasper Vos[1]
[1]The Hague University of Applied Sciences

Parallel 3 - Artificial Intelligence and Machine Learning, Room 3.9, September 12, 2023, 14:45 - 15:45

Biography:
Lampros Stergioulas is UNESCO Chair in AI and Data Science for Society in the Netherlands, and professor of Data Science and at The Hague University of Applied Sciences, where he leads the Data Science research group in the Faculty of IT & Design. Since March 2022, he is the holder of the Unesco Chair 'Artificial Intelligence and Data Science for Society'. Previously, he has been chaired professor in Business Analytics at the University of Surrey Business School and in Computer Science at Brunel University London (Southern England). Lampros is also active for the European Commission as an expert in the fields of artificial intelligence, data science and research ethics. He also serves as an expert evaluator for various programmes sponsored by the European Union and EU Member States. Lampros studied informatics and physics in his first degree, and obtained an MSc(ENG) and a PhD in electrical engineering from the University of Liverpool, UK.

He has written more than 200 scientific publications and supervised and examined many PhD theses in the fields of data science, human-centred computing, health informatics, data-driven social innovation, modelling and simulation, and intelligent systems.

He has been principal investigator in more than 30 international projects, and coordinator of 4 European research projects in which he collaborated with EU and national public organizations such as the European Centre for Disease Prevention and Control (ECDC), the European Medicines Agency (EMA), the European Commission, the National Health Service (UK) as well as national and regional authorities around the world.

Lampros's research interests lie in the fields of applied AI, data science and analytics, health informatics, data-driven management and innovation, system modelling and simulation as well as data ethics.

As the global aviation industry navigates the challenges of capacity planning and operational efficiency in an increasingly dynamic landscape, the potential for accurate prediction of passenger flight load has recently gained importance and significant interest. This study

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reviews earlier research which evaluated a range of commonly used prediction methods demonstrating variable performance, and proceeds to develop and validate a robust prediction algorithm for passenger flight load using XGBoost, an advanced machine learning methodology. The algorithm is grounded in an extensive dataset from Rotterdam the Hague airport, spanning the period from 2014 to 2021. It uniquely leverages features such as future bookings, the number of passengers from preceding days, and cyclical monthly patterns – represented using Repeating Radial Functions – to predict passenger traffic. The algorithm operates in two distinct steps: first, it forecasts daily passenger volumes based on these features; following this, it refines the daily forecast by fitting it into an empirical distribution of passenger flow throughout the day, effectively transforming daily predictions into an hourly forecasting format. A comprehensive cross-validation of the prediction algorithm over the entire dataset demonstrated a Root Mean Square Error (RMSE) of 300 passengers per day, indicative of substantial precision and reliability. This pioneering application of XGBoost in the aviation industry paves the way for advanced, data-driven approaches in enhancing airport operational efficiency and strategic capacity management, towards a more sustainable future for air travel.

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AI (Machine Learning and Deep Learning) enabled sustainable food supply chain; impact on fresh produce environmental performance

Mr. Samsad Reza[1], Professor Amin Hosseinian Far[1], Professor Dilshad Sarwar[1]
[1]University Of Northampton

Parallel 3 - Artificial Intelligence and Machine Learning, Room 3.9, September 12, 2023, 14:45 - 15:45

Biography:
I am lecturer in Business Analytics at the University of Northampton. I mainly teach Data science, Digital twins ans IoT at the MSc level. My research interest is on Machine Learning, Deep learning, Digital twins, IoT, Lean logistics and Sustainability.

Purpose –
The purpose of this paper is to investigate a conceptual model that combines Artificial Intelligence (AI) specifically the practice of using Machine Learning (ML) and Deep Learning (DL) with Sustainability practices in the food supply chain and to explore the combined impact on the fresh produce environmental performance.
Main Discussion-
197 countries around the world have signed the Kyoto protocol to reduce the greenhouse gas emissions and in the Paris Agreement all the world leaders have ratified the plan to keep the global warming below 2.0 degree Celsius (UNFCC, 2015). Recently in the COP26 at Glasgow, UK, a global net zero was planned before 2050 and to keep the global warming under 1.5 degree (COP27, 2021). Therefore, supply chains across the industries need to align their technological innovations such as introducing AI with their existing sustainability practices. Food supply chains are one of the main contributors of the global greenhouse gas emissions. Consequently, it is important to investigate how they can use the industry 4.0 technologies such as the AI and combine them with sustainability practices to improve their environmental performances.
Methodology-
We intend conduct an original research and with this view we intend to collect survey data from a list of food supply chains from India and explore the conceptual model using Structural Equation Modelling (SEM) using SmartPLS 4.0 software. Our survey items would be built on the three constructs we identified. Moreover, we want to delve into the investigation of whether the AI construct mediates the relation between the Sustainability practices and Environmental performances in the fresh produce food supply chain. We would control the effect of plant size and age in the analysis so that they do not affect the result.

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AI and digital skills in the UK manufacturing exporting firms

Dr Aida Garcia-Lazaro[1]
[1]University Of Bath, Institute for Policy Research

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
I am an economist studying the impact of digitalisation on the labour market. I focus on AI and digital skills.

I am a Research Associate at the Institute for Policy Research, University of Bath, UK. I joined the Made Smarter Innovation: Centre for People-Led Digitalisation in 2021.

In my research, I use applied econometrics, machine learning and modelling to examine the topics I am interested in.

Previous work has focused on other dimensions of technological change and the effects on the labour share, Brexit and the labour market.

This paper examines to what extent the UK exporting manufacturing companies show a greater demand for AI and digital skills than their peers concentrated on the domestic market. We use the Lightcast dataset on online vacancies from 2012 to 2023 and match it with information from FAME to create a firm-level dataset that merges information on digital skills, exporting variables, and companies' financial and investment conditions. This study conducts two baseline analyses. First, it provides a detailed overview of the AI and digital skills dispersion across the UK for the manufacturing sector. Second, it assesses the causal effect of being an exporting manufacturing company and its AI and digital skills demand controlling for firm metrics and regional effects. This paper's preliminary results show a positive and significant impact between being an exporting manufacturing company and the demand for workers with AI skills. These findings are consistent with the intense international competition that exporting companies face in the global markets to keep the market share. We present additional analysis at the regional level to give insights into the levelling-up agenda. Finally, the paper shows a set of robustness checks to accompany our baseline estimations.

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Harnessing Big Data Analytics for Enhanced Supply Chain Efficiency in Omnichannel Retail: A Multi-case Study Approach

Prof Maria Trindade[1], Prof Giuseppe Stabilini, Prof Marco Bettucci
[1]Sda Bocconi

Parallel 10 - Artificial Intelligence and Machine Learning, Room 3.5, September 14, 2023, 14:30 - 16:00

Biography:
Maria Alice Trindade is Junior Researcher of Operation and Supply Chain Management at SDA Bocconi School of Management. Maria Alice is Invited Teaching Assistant of Operation Management and Business Intelligence at Católica Porto Business School.

Her research activities focus on applied research in the retail sector, namely concerning inventory management, procurement, and distribution. Her current research addresses three main questions. The first is the channel choice for omnichannel retailers. The second focuses on the role of resilience and sustainable practices in omnichannel retailers. The third aims at determining the best practices for AI in omnichannel retailers.

Maria Alice is the author of articles on the subject. Her work has been published in Journal of Hospitality and Tourism Insights. Flexible Services and Manufacturing Journal, International Journal of Management Science and Engineering Management, Operations Research and Decisions, among others. She is a member of the Monitoring Committee of the PhD in Management at Faculty of Economics of the University of Porto and one of the founders of Fink.

Maria Alice earned a MSc in Management from Faculty of Economics, Oporto University and a PhD in Management from Faculty of Economics, Oporto University.

This paper presents a comprehensive case study analysis on the implementation of Big Data Analytics (BDA) in omnichannel retailers. The study investigates the strategic adoption of BDA and its impact on supply chain optimization and operational performance, providing valuable insights into the integration of OR principles and methodologies with BDA in an omnichannel retail context. By drawing upon a combination of qualitative and quantitative data, this study maps the multifaceted aspects of BDA implementation. It examines the production system characteristics of the cases and categorizes them as "discrete" or "process" directed, utilizing prior knowledge and additional analysis. This categorization provides a deeper understanding of the operational implications of BDA implementation. Within the context of OR, this research addresses several key areas. Firstly, it explores the

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role of BDA in informing and optimizing supply chain strategies, aligning with the objective of improving operational efficiency and effectiveness. BDA enables retailers to analyze vast amounts of data collected from various channels, enabling data-driven decision-making in areas such as demand forecasting, inventory management, and route optimization. Furthermore, this study investigates the analytics techniques employed by retailers, including descriptive, inquisitive, predictive, and prescriptive analytics. These techniques align with various OR methodologies, such as data exploration, simulation, optimization, and decision-making. Additionally, the study examines the BDA software used by retailers, such as CRM systems and business intelligence tools, which incorporate advanced analytical capabilities and data visualization techniques. This integration aligns with OR principles of leveraging technology and computational tools to support decision-making and optimization. Moreover, the study explores the ethical concerns surrounding BDA implementation, reflecting the growing importance of ethical considerations in OR research. It investigates the protocols and processes established by retailers to address these concerns, ensuring responsible data usage, privacy protection, and compliance with ethical guidelines. By mapping the challenges and success factors of BDA implementation in omnichannel retailers, this research provides insights into the practical implications for OR practitioners and provides a framework for accurate and consistent data collection, effective data integration and management.

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Artificial Intelligence (AI) for Lean Manufacturing: A systematic Review of the Literature

Mr. Samsad Reza[1], Professor Jose Arturo Garza-Reyes[2], Dr. Tony Anosike[2]
[1]University Of Northampton, [2]University of Derby

Parallel 10 - Artificial Intelligence and Machine Learning, Room 3.5, September 14, 2023, 14:30 - 16:00

Biography:
I am a Lecturer in Business Analytics at the University of Northampton. I am also a PhD student at the University of Derby investigating the interrelations among Artificial Intelligence, Lean manufacturing and Sustainability and to delve into their combined effect in improving environmental sustainability practices.

I was awarded the best postgraduate thesis award for my MA in Logistics and Supply chain at the University of Greenwich. Following that I achieved the Business School Scholarship for my PhD at University of Derby.

My Research interests are on Artificial Intelligence, Machine Learning, Lean manufacturing, Sustainability, Digital Twins and Internet of Things.

Purpose-
The purpose of the paper is to shed some light upon how the Artificial Intelligence (AI) is facilitating the lean manufacturing practices and brings about more productivity and efficiency in the manufacturing supply chain. The use of AI, more particularly the use of Machine Learning (ML) and Deep Learning (DL) in facilitating the lean manufacturing practices across the industries. We aim to portray the state-of-the-art knowledge about the interrelation of these two supply chain practices and to investigate the complementary nature of AI to facilitate the lean practices such as the automation, JIT, Kaizen, 5S and so on.

Design/ Methods-
We conducted a systematic literature review on exiting publications on the impact of Artificial Intelligence on the Lean manufacturing. Initial search resulted in 3,347 papers. We then limited the search using key words only for Lean manufacturing and Artificial intelligence and limited the publications to last ten years (2013 to 2023). Further refinement was conducted by limiting the journals to business, operations and economics clusters. As a result, we came up with 364 papers. We then opted for selecting the journals only and discarded the books and websites. These resulted in a final number of journals to 114.

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Findings-
The paper would collate the publications and present the statistics derived from the Scopus search presenting the journals and countries that published a significant number of journal papers about the topic. We expect to collate the main themes of publications and discuss the lean and AI practices reported in the journals.

Value/Originality –
Given that use of AI, ML and DL in lean manufacturing is a fairly new phenomena, very few research were conducted where most of the publications are conceptual papers with few case studies and empirical analysis. It is, therefore, important to portray a comprehensive picture of the state-of-the-art knowledge about these two variables and their intricacies.

Implications –
The research implicates a comprehensive theoretical understanding of the existing knowledge around the topic that augments the understanding of how the use of AI can facilitate the lean manufacturing practices particularly for the supply chain and operations management.

Refinement and Adaptive Satisficing in Cognitive Architectures for Robots

Dr. Mohan Sridharan[1]
[1]University Of Birmingham

Parallel 10 - Artificial Intelligence and Machine Learning, Room 3.5, September 14, 2023, 14:30 - 16:00

Biography:
Dr. Mohan Sridharan is a Reader in Cognitive Robot Systems in the School of Computer Science at the University of Birmingham (UK). Prior to his current appointment, he held academic positions at The University of Auckland (NZ) and at Texas Tech University (USA). Dr. Sridharan received his Ph.D. from The University of Texas at Austin (USA). His research interests include knowledge representation, cognitive systems, control systems, and machine learning, as applied to robots and agents collaborating with humans. He is also interested in developing algorithms for automation in non-robotics domains such as climate informatics, agriculture, and transportation.

Web page: http://www.cs.bham.ac.uk/~sridharm

Data-driven (deep) learning methods represent the state of the art for many problems in AI and robotics. These methods solve an optimization problem using a large dataset of labeled training examples and considerable computational resources. Many problems in robotics, on the other hand, require the robot to make decisions over long time horizons and in previously unseen situations based on limited data and computational resources. In a departure from existing work, I will describe an integrated cognitive architecture for robots that leverages the complementary strengths of knowledge-based and data-driven methods for reasoning, control, and learning. The architecture computationally encodes the principles of step-wise refinement and ecological rationality. It is based on formally-coupled transition diagrams of the domain at different resolutions, with a fine-resolution transition diagram defined as a refinement of a coarse-resolution diagram. For any given goal, non-monotonic logical reasoning with prior commonsense knowledge and rapidly learned models of the behavior of other agents provides a plan of abstract actions at the coarse resolution. Each abstract action is implemented as a sequence of concrete actions by automatically zooming to and reasoning with the relevant part of the fine-resolution transition diagram. Probabilistic models of the uncertainty in sensing and actuation are used when available, and action outcomes and observations are used for subsequent coarse-resolution reasoning. In addition, reasoning guides interactive learning of previously unknown domain knowledge, automatically selecting and using heuristic methods that focus on adaptive satisficing instead of optimization to learn quickly from limited training

examples. Furthermore, the architecture enables the robot to interactively provide relational descriptions as on-demand explanations of its decisions and beliefs. I will illustrate the architecture's capabilities in the context of simulated and physical robots assisting humans and collaborating with other robots in moving and manipulating objects in indoor domains.

Behavioural OR

Cognitive Operations: Models that Open the Black Box and Predict our Decisions

Professor Konstantinos V. Katsikopoulos[1]
[1]University Of Southampton

Parallel 1 - Behavioural OR, Room 3.1, September 12, 2023, 09:15 - 10:45

Biography:
Konstantinos is a Professor of Behavioural Science at the University of Southampton where he is also research director of the Business School; previously he was visiting assistant professor at the Massachusetts Institute of Technology, senior research scientist at the Max Planck Institute for Human Development and German Science Foundation fellow. Konstantinos is an internationally recognised researcher in the interdisciplinary study of decision making, helping shape the field of behavioural operations research and chairing the behavioural group at the OR Society. He is associate editor of the Journal of Mathematical Psychology and of Judgment and Decision Making, as well as first author of "Classification in the Wild: The Science and Art of Transparent Decision Making" (MIT Press, 2020) and "Cognitive Operations: Models that Open the Black Box and Predict our Decisions" (Palgrave Macmillan, 2023).

This work surveys how people make decisions under risk and uncertainty in operational settings, and opens the black box by specifying the cognitive processes that lead to human behaviour. Drawing on economics, psychology and artificial intelligence, I will provide an innovative perspective on behavioural operations: I will show how to build optimisation as well as heuristic models for describing human behaviour and how to compare such models on various dimensions such as predictive power and transparency; and I will also briefly discuss interventions for improving human behaviour. The talk will be particularly valuable to academics and practitioners who seek to select a modelling approach that suits the operational decision at hand.

Investigating Retail Investors' Response to News Sentiment through Agent-Based Modelling

Dr Heather He[1], Mr Junda Liu
[1]Bangor University, [2]University of Bristol

Parallel 1 - Behavioural OR, Room 3.1, September 12, 2023, 09:15 - 10:45

Biography:
Heather is a Lecturer in Data Science/Analytics at the Bangor Business School, Bangor University, UK. Prior to this position, Heather was a doctoral researcher at the Centre for Risk Research, University of Southampton, UK. Her research interests are so far focused on (i) applied data science for finance & business analytics, (ii) behavioural risk-taking & decision-making, and (iii) financial technologies. Heather's research work has been presented at international conferences and workshops, including INFORMS and ACM International Conference on AI in Finance (ICAIF). Heather also serves as a reviewer for several internationally leading academic journals. Heather has interests and a track record in developing and delivering data science and business analytics programmes at undergraduate and postgraduate levels.

With the escalating influence of digital news and social media on financial markets, understanding the behavioural patterns of retail investors in response to news sentiment is imperative. This study employs Agent-Based Modelling (ABM) to scrutinise the diverse behavioural responses of retail investors.

Our model segregates investors into trend-chasers, contrarian traders, and noise traders. Trend-chasers buy after positive news and sell after negative, while contrarian traders behave conversely, aiming to buy undervalued assets following negative news. Noise traders, acting independently of news sentiment, add an unpredictable element to the system.

Following the findings of De Bondt (1998) [De Bondt, W. F. M. (1998). A portrait of the individual investor. European Economic Review, 42(3-5), 831-844.], our model proposes that retail investors identify naive patterns in past price movements and formulate their trading decisions accordingly, reflecting a heuristic-based approach to investment decision-making.

Our simulation provides a rich exploration of their behavioural responses to news sentiment. This nuanced understanding of retail investors' behaviour contributes to a more comprehensive portrayal of financial decision-making in the digital age.

Through a detailed investigation of how news sentiment impacts the interaction among different types of investors, this research provides fresh insights into the intersection of behavioural finance, news sentiment, and computational modelling.

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Heuristics for Non-Default Staple Decision

Mrs Lidia Mayangsari[1], Professor Konstantinos V. Katsikopoulos[1], Professor Stephan Onggo[1]
[1]Southampton Business School, University of Southampton, [2]School of Business and Management, Institut Teknologi Bandung

Parallel 1 - Behavioural OR, Room 3.1, September 12, 2023, 09:15 - 10:45

Biography:
Currently a postgraduate research student at Southampton Business School, University of Southampton. Professionally working as a faculty in the School of Business and Management, Institut Teknologi Bandung, West Java, Indonesia. Mother of two beautiful sons--six and three years old.

Rice and Indonesia have been inseparable. The per capita rice consumption had reached 139 kg per capita per year, exceeding the FAO standard of 60-65 kg per capita per year (Suryana, 2015).

However, there are more alternative staples aside from rice produced in the country. Ariani and Pitono (2013) argued that the intense top-down rice policies forced the abandonment of other staples available like sago and tubers as non-rice local staples (Sutianto, 2015). We present an exploratory study of the simple decision rules (hereafter heuristic) of non-rice local staple consumption among Indonesian consumers. We induced the heuristics by interviewing consumers across the country previously tasked to record a three-day staple food diary. Identifying heuristics is the key to staple diversification and improving decision-making (Katsikopoulos, 2022). Data were transcribed verbatim and cross-coded in multiple iterations. Some representative topics employed to explore the heuristics of choosing non-rice local staples are attitudes, consumption frequency, and subjectivity.

We found three heuristics related to non-rice local staples: goal-based, seasonal, and complementary, which can also help us to articulate the nudging strategies to promote staple diversification. In the goal-based heuristics, our participants were concerned with health awareness and knowledge. When the condition is status quo, rice is the default staple. However, non-rice local staples have a specific place in emergencies. The seasonal heuristics represents the supply shortage and uncertain distribution of non-rice local staples in Indonesia and are merely found in participants living in rural areas. On the other hand, complementary heuristics are embedded in all participants as a stigma--non-rice local staples are dependent on rice. They are considered less staple than rice, symbolizing a lower class of staple.

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From the methodology standpoint, our diary and interview approach engaged uncertainty and risk in their nature, allowing us to get closer to understanding behaviour from a real-life setting. Our empirical approach was assembled in the wild (Katsikopoulos et al., 2021), potentially expanding our understanding of behaviour in the staple food choice context.

Smart Service Quality in Hospitality - an MCDM Assessment

Dr Nur Cavdaroglu[1], Dr Shilpa Iyanna[1], Dr Monika Foster[1]
[1]Northumbria University

Parallel 2 - Behavioural OR, Room 4.5, September 12, 2023, 13:15 - 14:45

Biography:
Dr. Ayvaz-Cavdaroglu is Assistant Professor of Business Analytics at Newcastle Business School, Northumbria University. She received a BS degree in Industrial Engineering from Middle East Technical University and her MSc and Ph.D degrees from the Department of Industrial Engineering & Operational Research at Columbia University. She worked as a post-doc researcher in Whitman School of Business at Syracuse University.

Ayvaz-Cavdaroglu's research focuses on applications of revenue management and pricing in health care, hospitality, and agriculture sectors. She is also interested in circular economy and sustainability in supply chains. Her work has appeared in journals such as Omega, Production and Operations Management, Journal of Revenue and Pricing Management, Journal of Cleaner Production, Journal of Travel Research and as book chapters.

Among the many changes we have witnessed in the past few decade, technology is one of the biggest game changers that has significantly transformed consumer behaviour. The prevalence of technology in the hospitality and tourism industry requires immediate attention as consumers' experience with technology-based services is likely to influence service quality perception. Service quality is an important factor measuring how well the service delivered matches customer expectations.

Within the hospitality sector, the service outcomes are described as being predominantly psychological and involve a range of experiences that influence customers' evaluation of the service as well as their satisfaction with a given service. However, recent changes in the hospitality and tourism sector and customer expectations and behaviour make it necessary to revisit and reconstruct the SERVQUAL scale to make it more relevant to measure customer expectations.

The aim of this on-going project is to identify the dimensions and sub-dimension of the extended SERVQUAL model and apply the Best Worst Method (BWM) to investigate the weight of each dimension from the consumers perspective. Despite the increasing popularity of BWM and other multi-criteria decision making (MCDM) techniques in hospitality, their application in alignment with SERVQUAL and other similar quality scales is limited. This project attempts to fill this gap by measuring the extended dimensions of service quality in the hospitality sector using MCDM techniques.

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Are pie charts evil? Investigating data visualisation dogma and its impact on our ability to communicate quantitative analysis to decision-makers

Dr Andy Hill[1]
[1]University Of Surrey

Parallel 2 - Behavioural OR, Room 4.5, September 12, 2023, 13:15 - 14:45

Biography:
Andy is a Senior Lecturer in Business Analytics. His specialism lies in quantitative operational research methods, including Monte Carlo simulation, Machine Learning and Data Analysis.

Andy has worked in government, industry and academia, striving to help improve decision-making through the use of modelling and data analysis. He has consistently come up against the problem of trying to communicate complex quantitative information to lay decision-makers, and so his current research lies around the theme of trying to translate complex analysis into simple, intuitive decision support.

As quantitative scientists we forget just how hard most people find dealing with maths and data. This creates a huge problem if lay decision-makers can't understand our complex analyses. At best, our analysis isn't used in the decision-making process, at worst it gets corrupted and abused.

Data Visualisation is one solution to the problem, where we can leverage the massive power of our visual processing system to translate complex analysis into simple, intuitive insights. Large strides in producing user-friendly graphs and charts have been made by prominent visualisation experts such as Edward Tufte, William Cleveland and Stephen Few. But delving into the data viz literature, much of what we "know" about data visualisation is based on practictioner experience and opinion - there's surprisingly little quantitative research into the subject. What there is has focused almost exclusively on accuracy, but this is just one factor that makes a chart or graph successful.

For example, in the field of Data Analytics, the hatred for pie charts is near ubiquitous. However, this seems to be based on the misconception that when looking at a pie chart we compare areas and angles, and that this is less accurate than comparing lengths (as in a bar chart). But there is no consistent evidence in the literature to support this.

Of major importance is that there seems to be little research into the visualisation of probability distributions, a key output of many OR analyses.

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Thus, I will summarise the primary research I have been doing to fill in some of these gaps, which has used eye trackers to give much richer information than has been possible before.

For example, pie charts are arguably just as good as bar charts when used correctly. You may also be suprised at just how bad people are at interpreting probability distributions, which has worrying implications for what decision-makers understand when we present the results of simulation models to them.

In summary, I will argue there is a need to rethink how we do research in the data visualisation field, so that we can design better graphs and charts for decision-making.

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What happens when the client doesn't like the answer?

Dennis Sherwood[1]
[1]The Silver Bullet Machine Manufacturing Company Limited

Parallel 2 - Behavioural OR, Room 4.5, September 12, 2023, 13:15 - 14:45

Biography:

Dennis Sherwood runs now runs his own consulting business, Silver Bullet, having been a consulting partner in Deloitte, Haskins + Sells (a predecessor of PwC) and an Executive Director at Goldman Sachs.

Dennis is the author of many articles and blogs, the co-author of three books, and sole author of twelve others, including 'Seeing the Forest for the Tress - A manager's guide to applying systems thinking' (Nicholas Brealey, 2002), 'Strategic Thinking Illustrated - Strategy made visual using systems thinking' (Published by Routledge, 2022), which was short-listed in the 'Specialist book Category' of the 2023 UK Business Book Awards, and also 'Missing the Mark - Why so many school exam grades are wrong, and how to get results we can trust' (Canbury Press, 2022) - which is relevant to this presentation!

This stream is described as a "look into how considering human behaviour does or does not, improve performance of OR models".

I'd like to turn that around - if I may! - and "look into how the results of an OR study does, or does not, improve human behaviour". With the emphasis on 'does not'!

To explain... most presentations at conferences are about success: great analysis leading to a clever solution; the client is delighted, and everyone lives happily-ever-after.

But what happens when the analysis gives results which the client just does not like? Do you 'bend' the results to suit the client's preferences? Do you try to persuade the client to accept the results, even if they are bad news?

I've had direct experience of this, with a client in the public sector, and it's been a struggle!

Am I alone in having had this (miserable!) experience, or have others faced this too?

If so, please come along to this session, for it would be very valuable to share notes! For this surely is a dark - and perhaps rarely discussed, but important - aspect of behavioural OR.

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Newsvendor and the trade credit financing: an experimental analysis

Mr. Mohd Mujahid Khan[1], Dr. Vipin B[2]
[1]PhD student, Indian Institute of Technology Kanpur, [2]Assistant Professor, Indian Institute of Technology Kanpur

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:

Specialization: Operations analytics, Supply chains

Research domain: Behavioral operations, Operations-finance interface, Inventory decisions under uncertainty

Short profile:

Senior Research Fellow at IIT Kanpur | M.Tech. from JMI New Delhi | Associate Member I.E. (India) | Student Member POMS (US) | Student Member ORS (UK)

Former: Maulana Azad National Research Fellow | Faculty Member at Central Plastics Institute Lucknow | Faculty Member at SRMS CET Bareilly

We investigated a financially constrained newsvendor who procures products and obtains trade credit from the supplier in a dyadic supply chain. The newsvendor trade-offs between ordering more products to maximize revenue and acquiring additional funds to finance the purchase. Thereby, this work aims twofold: (i) to experimentally identify the newsvendor's behavior in the supply chain under financial constraints, and (ii). to develop a model describing the observed behavior in a financially constrained supply chain based on demand chasing, bankruptcy risk, and loss aversion. We used performance-based, monetarily incentivized, controlled laboratory methods. The experiment involved is a 2 × 2 within-subjects design, with non-financing vs. financing and low-profit margin (LP) products vs. high-profit (HP) margin products under financing, as treatments. Forty-five students participated who studied the newsvendor model, trade credit, the financially constrained newsvendor model, and allied mathematics during their coursework. The pay is divided as fixed show-up fees plus performance-based variable compensation. The sessions average one hour in duration. The statistical model is obtained from experimental data using the Fixed Effect Panel Linear Modeling (FE PLM) approach. Further, a loss aversion model (with reference-dependence) that effectively captures the observed behavior is presented. The study finds that: (i). In real-world settings, financially-constrained human decision-makers underorder. (ii). This deviation from optimality (i.e., underordering tendency) is more

pronounced when taking inventory decisions for high-profit margin products than low-profit margin products. (iii). The partial-demand chasing model captures the behavioral drift for all our treatments (i.e., non-finance/finance, LP/HP). Partial-demand chasing with bankruptcy FE PLM significantly captures the data for financially constrained newsvendor. (iv). The loss aversion and reference dependence model proves the underordering behavior of newsvendors in financial settings. The managerial implications suggest that by understanding the impact of financial constraints and cognitive biases of agents in a supply chain on inventory management and procurement decisions, supply chain managers can develop more effective strategies and customized incentive mechanisms. The managers fail to take advantage of the limited liabilities associated with bankruptcy risk. The issue is more profound for high-profit margin products.

Combinatorial Optimisation

Optimisation of batch biodigesters production scheduling

Mr. Arthur Barreto[1,2], Professor Sanja Petrovic[1], Adriana Cherri[2], Helenice Silva[3]
[1]Nottingham University Business School, [2]Universidade Estadual Paulista, [3]Universidade Estadual Paulista

Parallel 1 - Combinatorial Optimisation, Room 4.5, September 12, 2023, 09:15 - 10:45

Biography:
I'm an Industrial engineer with focus in Combinatorial Optimization. Right now in my PhD I explore how to schedule a set of biodigesters to produce biogas and minimize production losses or excess, but I have also dealt with many others industrial problems, all of them under the supervision of Dr. Adriana Cherri.

The production of biogas in biodigesters is a recurring theme in research regarding renewable energy sources. However, its production scheduling has not been fully explored and yet can minimise the waste of economic resources by optimally alocating biodigesters in a planning horizon. To complete this gap, this paper presents a multi-period mathematical model for product cost planning in a set of batch biodigesters. The objective of this model is to minimise the difference between the produced amoung of biogas and the biogas demand for each period, through alocating each biodigester to each organic matter (input) in planning horizon. The linear optimisation model also segments the periods into 3 groups: pre, during and post-planning horizons. This is performed so the biodigesters can meet the first biogas demands by performing in advance or later in the planning horizon. The computational experiments have been implemented with variations in the number of biodigesters, demand's constancy and planning horizon's extent. Results have shown that inconstant demands benefit by the operation of biodigesters in periods previous to the planning horizon, which reduces the difference between production and demand in the long term. However it also leads to an excess/missing production in the short term.

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Synchronizing delivery and installation with vehicle sharing: A hybrid adaptive large neighborhood search

Mr. Mehmet Serdar Erdogan[1], Dr. Rym M`hallah[1]
[1]Kings College London

Parallel 1 - Combinatorial Optimisation, Room 4.5, September 12, 2023, 09:15 - 10:45

Biography:
Professor M'Hallah focuses on modeling, analyzing and optimizing large-scale industrial and service systems using operations research and industrial/systems engineering techniques including but not limited to simulation, mathematical, constraint and dynamic programming, math heuristics and computational intelligence combined with techniques from probability, statistics. Primary application areas include health care, manufacturing, vehicle routing, deterministic and stochastic scheduling, cutting and packing, telecommunication networks, and quality control.

Phd Candidate Mehmet Serdar Erdogan focuses on combinatorial optimisation mainly on routing problems. He has knowledge on various operational research areas such as mathematical modelling, math heurisctics, multi-objective optimisation and exact algorithms.

This paper presents a real-life synchronized delivery and installation problem with vehicle sharing (DIVSRP). Two special-purpose fleets of vehicles serve a set of customers within their specified time windows. Delivery vehicles drop products to customers while installation vehicles drop and pick up technicians without necessarily waiting for them. Delivery must precede installation. This paper models DIVSRP as a mixed integer linear program, which solves small-sized instances. For large instances, this paper proposes a heuristic HALNS that hybridises adaptive large neighborhood search and variable neighborhood search. Extensive experimentation provides computational evidence of the superiority of HALNS when solving well-known benchmark instances of (synchronized) vehicle routing problems with time windows and its effectiveness in tackling newly proposed DIVSRP instances. HALNS outperforms two state-of-the-art algorithms by an average 6.41% and 12.43% for synchronized vehicle routing with time windows benchmark instances. It further provides computational evidence of the benefits of shared installation vehicles: Total cost decreases by 41.72% and 35.35 % as the installation vehicle capacity increases for tight and large time windows respectively.

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Improving computational efficiency of depth-first binary search (DFBS) in Logic-Based Benders' decomposition

Miss Aigerim Saken[1], Dr Stephen J. Maher[1,2]
[1]University Of Exeter, [2]Quantogonia

Parallel 2 - Combinatorial Optimisation, Room 4.16, September 12, 2023, 13:15 - 14:45

Biography:
PhD student in Mathematics at University of Exeter.

Main focus of my research are acceleration techniques for logic-based Benders' decomposition.

This talk presents new approaches for improving computational efficiency of depth-first binary search (DFBS) in Logic-Based Benders' decomposition (LBBD). Formulating strong Benders' cuts is crucial in reducing the solution time of LBBD. DFBS strengthens optimality and feasibility cuts by identifying an irreducible subset of variables or constraints that prove optimality (or infeasibility) of the inference dual subproblem, thus reducing the size of the cuts. In order to accelerate the search for the irreducible subset, we propose three new heuristics based on variable sorting and grouping of variables. For the computational study we consider minimising tardiness problem for cumulative facility scheduling. We evaluate the approaches by comparing the trade-off between the computational effort to strengthen the cuts and the impact the cuts have on the algorithm. The results show that the proposed approaches outperform the default DFBS.

An exact approach towards solving a hydrogen refuelling network design problem with pipelines

Dr Kit Daniel Searle[1], Dr Christa Searle[2], Dr Joerg Kalcsics[1]
[1]School of Mathematics and Maxwell Institute for Mathematical Sciences, University of Edinburgh, [2]Centre for Logistics and Sustainability, Edinburgh Business School, Heriot-Watt University

Parallel 2 - Combinatorial Optimisation, Room 4.16, September 12, 2023, 13:15 - 14:45

Biography:
Kit Searle is a University Teacher in Operational Research at the University of Edinburgh's School of Mathematics. His research interests are in combinational optimisation more specifically pertaining to exact and heuristic solution

approaches towards solving practical problems in facility location and vehicle routing. Recently he has been involved in projects related to designing electric vehicle charging infrastructure, construction scheduling and hydrogen refuelling infrastructure network design. Kit completed his PhD as part of the Stellenbosch Unit for Operations Research in Engineering at Stellenbosch University. He was also recipient of the Operations Research Society of South Africa's annual prize for best Master's thesis in South Africa.

In this presentation I will present a network design model which is employed to obtain the minimum cost hydrogen refuelling infrastructure. The network design model takes into consideration both location and supply decisions. More specifically, the model must determine where to locate hydrogen refuelling stations and how the hydrogen must be supplied to each refuelling station. For the supply of hydrogen we consider local hydrogen supply and off-site hydrogen supply. In the latter case the hydrogen must be distributed to the refuelling stations by means of tube trailers or a hydrogen pipeline. The difficulty of solving the network design problem arises from the hydrogen pipeline routing decisions. This will be the focus of the presentation. More specifically, I will present three different formulations and two different cutting plane algorithms to solve this problem. We then compare each of the formulations and solution algorithms in a preliminary computational study where we found that the classical flow formulation with a set of valid inequalities is the most efficient. Finally, I will present a real-life case study in the north of England where we found that allowing hydrogen to be delivered by pipelines made a significant improvement in the objective function.

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Community OR

Advancing Community Operational Research education for improving learning relevance and community engagement

Dr David Salinas-navarro[1]
[1]Aston University

Parallel 1 - Community OR, Room 3.9, September 12, 2023, 09:15 - 10:45

Biography:
Dr David Ernesto Salinas-Navarro is a Senior Teaching Fellow and co-leader of the Community Resilience and Sustainability Education Lab (CoRSEL) at Aston Business School, Aston University. He is also a Knowledge Transfer Partnership (KTP) academic supervisor and external examiner at the University of Lincoln. Before, he worked at Tecnologico de Monterrey in Mexico. His research interest lies in improving systems to positively impact the sustainability of cities and their communities.

He holds a PhD degree in Business/Management Systems from the University of Lincoln, UK, an MBA from Tecnologico de Monterrey, and a BSc degree (Hons) in Aeronautical Engineering from Instituto Politécnico Nacional in Mexico. Dr Salinas-Navarro is a member of the OR Society, VP of the Production and Operations Management Society in Latin America, and the MIT SCALE Network Latin America, coordinating the Education Innovation initiative.

He has developed innovative educational initiatives such as the Healthcare Engineering Management Lab, the Lean Thinking Learning Space (LTLS), and the Social Lab for Sustainable Logistics (SLSL) to enrich Industrial Engineering, Systems Thinking, and Operations Management education. His innovative work obtained the Silver Award for Presence Teaching and Learning at the 2018 QS Reimagine Education competition.

This work explores Community Operational Research (COR) education through the use of active pedagogies for learning outcome development in the discipline and strengthening mechanisms for community engagement. Teaching and learning COR has gained little attention in incorporating novel pedagogical approaches to engage students in real-world problem-solving and developing skills such as critical analysis, systemic thinking, and complexity thinking, but also communication and teamwork, which are essential for success in both academic and professional settings. As COR involves meaningful engagement with the community (or communities), there is an opportunity for collaboration, active learning,

and the application of OR methods in learning experiences to address relevant real-world community problems. Hence, this work proposes the involvement of students as knowledge producers in identifying, approaching, analyzing, and solving complex problems in partnership with the public, community organizations, businesses, or government agencies. This approach allows students to bridge the gap between theory and practice, and gain a deeper understanding of how OR can be used to solve complex problems in various settings and increase its educational relevance. A framework for this purpose is provided in terms of a structure of active pedagogical methods to define how to learn in COR considering a constructive alignment and authentic assessment approach. The overarching goal is to create mutually beneficial partnerships between academia and the wider community, while also equipping students with valuable skills and knowledge. However, limitations and challenges do exist, such as identifying appropriate projects, communication and coordination with community stakeholders, and building partnerships that align with learning objectives while also meeting the community partner's needs. This work contributes to advancing teaching practice in COR, expanding mechanisms for community engagement, and enriching students' learning experiences. It also considers adopting current innovative pedagogies attuned to contemporary educational developments in Higher Education.

Working with Windmills

Dr Geeta Lakshmi[1]
[1]Univ Of Lincoln

Parallel 1 - Community OR, Room 3.9, September 12, 2023, 09:15 - 10:45

Biography:
Geeta is a director at Sustainable Hockerton and an Associate Professor at the University of Lincoln. She teaches finance and is interested in the area of sustainable finance

Community energy companies are an important backbone of the energy sector in the UK. Nearly 500 UK companies existed in 2021, collectively responsible for 300 megawatts with 217,489 people involved in the projects. Together they saved £3.35million from energy bills (Community Energy UK, 2021). The economic rules of how such communities function are not well developed in literature.

Elanor Ostrom (1971) propounded some general rules to keep a community flowing, however her work focused on more traditional communities. This paper explores how communities are formed and maintain their functioning, using her work as a starting point. The paper uses stakeholder theory to cement the role of community energy companies as a means of overcoming and mitigating Anthropocene risk. It further develops a metric which can be used to measure the effectiveness of such communities. Using the case study from a small Nottinghamshire village, we explore the above ideas in greater detail.

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Community Complex Systems

Dr Rebecca Herron[1]
[1]University of Lincoln

Parallel 4 - Community OR, Room 4.10, September 13, 2023, 09:00 - 10:30

Biography:
Rebecca is an Associate Professor in the School of Management at the University of Lincoln, UK. She is also an Honorary Research Fellow at the University of Exeter (Institute of Cornish Studies). Her research interests focus around Community OR, self-organising complex systems and non-profit management. She teaches Research Methods and Community Organisation, Sustainability and Development and is a joint Program Leader for the DBA Program at the Lincoln International Business School.

This paper considers how viewing communities as complex systems may help academics and other interested community members to support development within their communities. The paper starts by taking a look at the idea of Community-Based Research as an approach to conducting research. This takes the position that we are not observing communities from an external perspective but are in some way researching as part of community systems (albeit often as an invited other). This perspective of being in, rather than looking at, systems changes the ways we perceive our role and our capacities to act – moving Community OR (C+OR) practitioners from a position of external expert or facilitator to one of a co-producer; with all the challenges this can bring both for effective sustained engagements and for writing up the results of these engagements. The second aspect considered in this paper is the use of systemic tools and methods when working within communities. This discussion does not seek to create an exhaustive list of systemic methods used in C+OR but rather indicates some core systemic concepts found useful in the author's experience – both to shape activity and to plan, review and make sense of it. These tools and methods include those that build improved community self-observation and reinforce positive feedback loops (drawing from cybernetics and dynamical systems ideas), tools and methods that help analyse community networks (identifying hubs, isolated nodes and communication/co-ordination channels) and tools and methods that help us better understand ecological/resource relationships (exploring and better understanding relationships; including understanding interdependencies, the sources of resources that support community activity as well as sources of uncertainty, tension or conflicts). Finally, some wider connections with self-organising, complex systems are discussed. In doing this, this paper seeks to build connections to previous work in OR and Systems and invites reflections on other approaches in use by others. The author ends with her own reflections on the implications of this for practice – as researchers, community members and as teachers and learners.

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Studying Collective Resistance. A Community OR approach.

Dr Eliseo Vilalta-Perdomo[1]
[1]CoRSEL. Aston Business School. Aston University

Parallel 4 - Community OR, Room 4.10, September 13, 2023, 09:00 - 10:30

Biography:
Senior Teaching Fellow and co-director of the Community Resilience and Sustainability Education Lab (CoRSEL) at Aston Business School, Aston University, United Kingdom. He holds a PhD in Business and Management Systems awarded by the University of Lincoln, United Kingdom, and a BSc in Industrial and Systems Engineering and an MSc in Manufacturing Systems from Tecnológico de Monterrey, Mexico. Previous academic experience includes being Associate Professor in Operations and Logistics Management at Lincoln International Business School, University of Lincoln (2011-2020). He has also been a part-time Lecturer (1993-1999) and full-time academic (2000-2011) at Tecnológico de Monterrey, where he was Associate Professor, Head of the Department of Industrial & Systems Engineering (Campus Guadalajara), and Dean of the Division of Higher Education (Campus Irapuato). Eliseo has been involved in developing and implementing CBL initiatives since 2009 and has been coordinating a CBL pilot project financed by the EU Interreg Sea North Region Fund (2019-2022). He has been recognized with the Nigel Slack Teaching Innovation Award 2020 by the European Operations Management Association due to his latest work on challenge-based learning. He has also been awarded a Doctorate Honoris Causa by Universidad Privada Antenor Orrego, Peru, and fellowships by the Advance HE (former Higher Education Academy), the Chartered Institute of Logistics and Transport, the Cybernetics Society, and the Operational Research Society. He was co-editor of The Emerald Handbook of Challenge Based Learning.

Since Rosenhead's proposal in 1986 to look at communities as a relevant target for OR practice, many exercises on C+OR have been reported. These reports present OR practitioners playing different roles, such as: advisers, catalysts, consultants, devil's advocates, experts, facilitators, meeting leaders, or participants (Wong & Mingers, 1994), who must deal with different societal issues within communities. All these roles confront the challenge of how to define such societal issues. An example of such challenge is provided by Kingdon (1984) (presented in Liebl, 2002). This example shows how a case of traffic congestion can be described as: (a) a 'problem' of having generated too much traffic; (b) a 'problem' of having built insufficient roads; (c) a 'problem' of road pricing, or (d) a 'problem' of missing traffic control based on information and communication technology. These are all valid interpretations from the same symptom, but apart from their technical significance, none of these consider which is the impact that such traffic has in their communities. Is this traffic necessarily a bad issue that needs correction?

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Some approaches such as Critical Systems Heuristics (Ulrich, 1996) seem to help on defining the boundaries of the social issue and its relevance; however, these approaches do not necessarily provide insights to collectives on how to act and resist undesirable external interventions. Examples on central Mexico and a reflection on how C+OR can support some resistance are provided.

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Experiential Learning Labs for developing sustainability-related learning outcomes in Community Operational Research education

Dr David Salinas-navarro[1]
[1]Aston University

Parallel 4 - Community OR, Room 4.10, September 13, 2023, 09:00 - 10:30

Biography:

Dr David Ernesto Salinas-Navarro is a Senior Teaching Fellow and co-leader of the Community Resilience and Sustainability Education Lab (CoRSEL) at Aston Business School, Aston University. He is also a Knowledge Transfer Partnership (KTP) academic supervisor and external examiner at the University of Lincoln. Before, he worked at Tecnologico de Monterrey in Mexico. His research interest lies in improving systems to positively impact on the sustainability of cities and their communities.

He holds a PhD degree in Business/Management Systems from the University of Lincoln, UK, and an MBA from Tecnologico de Monterrey, and a BSc degree (Hons) in Aeronautical Engineering from Instituto Politecnico Nacional in Mexico. Dr Salinas-Navarro is a member of the OR Society, VP of the Production and Operations Management Society in Latin America, and the MIT SCALE Network Latin America, coordinating the Education Innovation initiative.

He has developed innovative educational initiatives such as the Healthcare Engineering Management Lab, the Lean Thinking Learning Space (LTLS), and the Social Lab for Sustainable Logistics (SLSL) to enrich Industrial Engineering, Systems Thinking, and Operations Management education. His innovative work obtained the Silver Award for Presence Teaching and Learning at the 2018 QS Reimagine Education competition.

This work examines Experiential Learning Labs (ELLs) in Community Operational Research (COR) education to promote sustainable development-related learning outcomes beyond in-classroom learning experiences. The ELLs aim to provide an interactive, immersive, and learner-centered approach to education through hands-on learning activities linked to relevant real-world situations regarding sustainability challenges in cities and communities. Learning experiences in ELLs are based on Kolb's Experiential Learning Cycle to articulate concrete experience, reflective observation, abstract conceptualization, and active experimentation activities for problem solving and decision making in COR education. Moreover, from an educational perspective, ELLs contribute to constructive alignment and authentic assessment through competency-based learning experiences. The proposed

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working framework for executing learning experiences in ELLs is based on four key stages: problem identification, community engagement, data collection and analysis, and action planning. Hence, this study exemplifies an implemented instance, namely, the Social Lab for Sustainable Logistics (SLSL) and learning experiences at a Mexican university. Findings suggest that ELLs can help to grow students' sustainability-related learning outcomes, engagement, and motivation in COR education. This research provides valuable insights into the key factors and challenges associated with implementing ELLs and highlights the potential of this approach for other educational contexts in Higher Education.

Continuous Optimisation

HiOp: the Optimization Solver for Exa-Scale Computing

Dr. Nai-Yuan Chiang[1], Dr. Petra Cosmin[1], Dr Katarzyna Swirydowicz[2], Dr Shrirang Abhyankar[2], Dr Slaven Peles[3]
[1]Lawrence Livermore National Laboratory, [2]Pacific Northwest National Laboratory, [3]Oak Ridge National Laboratory

Parallel 2 - Continuous Optimisation, Room 4.8, September 12, 2023, 13:15 - 14:45

Biography:
Nai-Yuan Chiang is a computational mathematician in the Center for Applied Scientific Computing at Lawrence Livermore National Laboratory. His works focus on high-performance computing optimization algorithms and optimization solvers for large-scale programing, with an emphasis on applications in energy infrastructure systems and machine learning. He is an experienced research engineer with a demonstrated history of working in the industry and national laboratories.

HiOp is an optimization suite for solving large-scale mathematical programming. It is a lightweight HPC solver that leverages application's existing data parallelism to parallelize the optimization iterations by using specialized parallel linear algebra kernels. Acceleration can be achieved via OpenMP, CUDA or HIP, using RAJA portability abstraction and different execution policies. HiOp was used to solve large-scale optimization problems on parallel machines equipped with both AMD and NVIDA accelerators. It has been applied to solve SC-ACOPF problems for networks with 10,000 buses, 32 renewable energy forecast scenarios and 1,000,000 contingencies on Frontier.

Proximal point type algorithms for nonconvex pseudomonotone equilibrium problems with applications in fractional programming

Prof. Dr. Felipe Lara[1]
[1]Universidad De Tarapacá

Parallel 2 - Continuous Optimisation, Room 4.8, September 12, 2023, 13:15 - 14:45

Biography:

Felipe Lara is an Assistant Professor at the Instituto de Alta Investigación (High research Institute) in the University of Tarapacá, in Arica, Chile. He obtained his Ph.D. degree in 2015 on continuous optimization in the University of Concepción, Chile. He has written 31 papers until now and his ersearch interest are on nonconvex optimization problems, from existence of solutions and optimality conditions to iterative algorithms.

In this talk, we present an small overview on 4 recent works regarding proximal point type algorithms for nonconvex pseudomonotone equilibrium problems. We present the usual proximal method, the relaxed-inertial method, the two-step extragradient method and the extragradient projected method, all of them for pseudomonotone equilibrium problems which are neither convex nor differentiable on the second argument of the bifunction. Finally, we present applications for classes of mixed variational inequalities based on fractional programming problems.

Relaxations for Robust Equilibrium Constrained Polynomial Problems with Applications

Dr Chuong Thai Doan[1]
[1]RMIT University

Parallel 2 - Continuous Optimisation, Room 4.8, September 12, 2023, 13:15 - 14:45

Biography:

Thai Doan Chuong is a Research Fellow at RMIT University, Australia. After obtaining a PhD in Mathematics at the Institute of Mathematics, Vietnam, in 2011, he received a Postdoctoral Fellowship from the Second Level Brain Korea 21-Project Fund, Pukyong National University, South Korea in 2011. In 2014, he was awarded a Vice Chancellor's Postdoctoral Research Fellowship from the University of New South Wales, Australia.

In this talk, we consider a polynomial program with equilibrium constraints in which the constraint functions and the equilibrium constraints involve data uncertainties. More precisely, we examine the uncertain equilibrium constrained polynomial optimization problem by establishing lower bound approximations and asymptotic convergences of bounded degree diagonally dominant sum-of-squares (DSOS), scaled diagonally dominant sum-of-squares (SDSOS) and sum-of-squares (SOS) polynomial relaxations for the robust equilibrium constrained polynomial optimization problem. We provide numerical examples showing how the global optimal value of a robust equilibrium constrained polynomial problem can be found by solving corresponding relaxations using commonly available programming packages. An application to electric vehicle charging scheduling problems is also presented.

The boosted dc algorithm for linearly constrained dc programming

Dr Vuong Phan[1]
[1]University of Southampton

Parallel 6 - Continuous Optimisation, Room 3.1, September 13, 2023, 16:00 - 17:00

Biography:
Lecturer in Operational Research, University of Southampton, UK (2019--)

The Boosted Difference of Convex functions Algorithm (BDCA) has been recently introduced to accelerate the performance of the classical Difference of Convex functions Algorithm (DCA). This acceleration is achieved thanks to an extrapolation step from the point computed by DCA via a line search procedure. In this work, we propose an extension of BDCA that can be applied to DC programs with linear constraints, and prove that every cluster point of the sequence generated by this algorithm is a KKT point of the problem. When the objective function is quadratic, we prove that any sequence generated by the algorithm is bounded and R-linearly (geometrically) convergent. Finally, we present some numerical experiments where we compare the performance of DCA and BDCA on two challenging problems: to test the copositivity of a given matrix, and to solve trust-region subproblems. Our numerical results demonstrate that this new extension of BDCA outperforms DCA both in running time and objective value of the solutions obtained.

A Fast Optimistic Method for Monotone Variational Inequalities

Dr. Michael Sedlmayer[1], Dr. Dang-Khoa Nguyen[1], Prof. Radu Ioan Bot[1]
[1]University Of Vienna

Parallel 6 - Continuous Optimisation, Room 3.1, September 13, 2023, 16:00 - 17:00

Biography:
Michael Sedlmayer is a postdoctoral researcher at the University of Vienna, Research Network Data Science, where he obtained his PhD from the Faculty of Mathematics in 2023. He is interested in the theoretical properties of optimisation and saddle point algorithms, which he likes testing on relevant and demanding machine learning problems.

We study monotone variational inequalities that can arise as optimality conditions for constrained convex optimisation or convex-concave minimax problems and propose a novel algorithm that uses only one gradient/operator evaluation and one projection onto the constraint set per iteration. The algorithm, which we call fOGDA-VI, achieves a o(1/k) rate of convergence in terms of the restricted gap function as well as the natural residual for the last iterate. Moreover, we provide a convergence guarantee for the sequence of iterates to a solution of the variational inequality. These are the best theoretical convergence results for numerical methods for (only) monotone variational inequalities reported in the literature. To empirically validate our algorithm we investigate a two-player matrix game with mixed strategies of the two players. Concluding, we show promising results regarding the application of fOGDA-VI to the training of generative adversarial nets.

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Data Envelopment Analysis

Considering time-lag effects in data envelopment analysis models

Professor Matthias Klumpp[1], Professor Adel Hatami-Marbini[2], Dr. Aliasghar Arabmaldar[3]
[1]School of Management, Politecnico di Milano, [2]Department of Logistics, Marketing, Hospitality and Analytics, Huddersfield Business School, University of Huddersfield, [3]Department of Business Administration, Faculty of Business and Economics, University of Göttingen

Parallel 2 - Data Envelopment Analysis, Room 3.16, September 12, 2023, 13:15 - 14:45

Biography:
Aliasghar Arabmaldar is postdoctoral researcher at Department of Business Administration, Faculty of Business and Economics, Georg-August-Universität Göttingen, Göttingen, Germany. He holds a MSc and Ph.D. in Applied Mathematics-Operations Research. His research interests include the efficiency and productivity measurement, Data Envelopment Analysis, Decision and Business Analysis, Optimization under uncertainty. He has published widely in the field of efficiency and productivity analysis in journals such as European Journal of Operational Research, OR Spectrum, Expert Systems with Applications, Optimization and etc.

Data Envelopment Analysis (DEA) is a prominent method family in efficiency analysis and operations research. Besides many advantages warranting large-scale research and application in management science, there is one important issue not yet explored sufficiently in detail, which is the time-lag problem. Multiple input and output types can be included in DEA calculations, but a clear connection to the expected and varying time-lags between the time position of input data on the one hand and output data on the other hand is not yet defined. For many production processes with low time-lag levels like car manufacturing or service processes like IT services this is not a major issue. But there are long time-lag setting between production inputs and outputs for example in airplane production or university research production processes, reaching up to timespans of years between input values and achieved output values. This paper explores this issue and the impact on DEA and especially its influence on the productivity growth calculation and results in a theoretical approach as well as with a specified application dataset regarding research and development (R&D) institutes. Results are highly relevant as non-observed time-lag issues may result in disadvantages in productivity calculation for growing or shrinking institutions or production units facing high levels of inflation as in the current business environment.
Keywords: Data envelopment analysis, Productivity measurement, Time-lag

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Incorporating production trade-offs in DEA models with ratio inputs and outputs: An application to schools in England.

Miss Junlin Wu[1], Dr Nikolaos Argyris[1], Professor Victor Podinovski[1]
[1]Loughborough University

Parallel 2 - Data Envelopment Analysis, Room 3.16, September 12, 2023, 13:15 - 14:45

Biography:
Junlin is a final-year PhD student at Loughborough University and a lecturer in business operatios at University of Greenwich. Her research is about efficiency analysis using data envelopment analysis models with a specific application area in secondary schools in England.

Inputs and outputs represented by ratio data (such as percentages and averages) often appear in efficiency applications along with volume data. As well known, such measures are inconsistent with the basic assumptions (axioms) on which the conventional variable and constant returns-to-scale (VRS and CRS) models of technology are based. The ratio-VRS (R-VRS) and ratio-CRS (R-CRS) models developed by Olesen, Petersen, and Podinovski (2015, 2017) address this issue and allow the incorporation of both volume and ratio inputs and outputs. In this paper, we extend the R-VRS and R-CRS models by accommodating additional production trade-offs between volume inputs and outputs and, similarly, between ratio measures. The specification of production trade-offs provides additional information about the production process and improves the efficiency discrimination of the resulting R-VRS and R-CRS models. We use an application in the context of school education to demonstrate the usefulness of the suggested methodology.

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New developments for modelling ratio inputs and outputs in DEA

Dr Grammatoula Papaioannou[1], Professor Victor Podinovski[1]
[1]Loughborough University

Parallel 2 - Data Envelopment Analysis, Room 3.16, September 12, 2023, 13:15 - 14:45

Biography:
Victor Podinovski is Professor of Operational Research at Loughborough Business School. His research interests include efficiency and productivity analysis of organisations, in particular using data envelopment analysis.

Inputs and outputs represented as ratio measures, such as proportions and percentages, require a different treatment compared to volume measures. The reason for this is that ratio measures invalidate the basic assumptions of DEA such as convexity of technology and scalability of data. In this paper, we consider established and new developments suitable for the treatment of ratio measures and illustrate our discussion by an application in the educational context.

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Finding objective criteria weights for scoring: The Automatic Democratic Method

Dr. Chris Tofallis[1]
[1]University Of Hertfordshire Business School

Parallel 3 - Data Envelopment Analysis, Room 3.16, September 12, 2023, 14:45 - 15:45

Biography:

Dr. Chris Tofallis is a Senior Lecturer in Operational Research at the University of Hertfordshire Business School, UK. He holds a first class honours degree in physics, a Masters degree in Operational Research (London School of Economics), and a PhD in applied mathematics.

His over-arching interest is to invent / develop better methods for analysing data and aid decision making. His peer-reviewed papers have been cited 1700 times (Google Scholar). They cover the following areas:

- *Development of alternative data fitting/ modelling methods for finding functional relationships with measurement errors in variables.*
- *Improved relative accuracy metrics for forecasting/time series analysis.*
- *Multi-criteria efficiency and performance measurement, including DEA (data envelopment analysis).*
- *Objective weighting methodologies for rankings / league tables.*
- *Risk measurement in finance.*

We consider situations where competing entities (organisations, products, services, etc.) are being compared on multiple attributes which are aggregated into an overall score. We present an objective way of weighting these attributes (to avoid personal judgement) which takes into account the largest attainable relative score for each entity.

The first step is to find the maximum relative score for each entity. These upper bound scores are found using Data Envelopment Analysis (DEA).

In the second step the final weights in the scoring formula are estimated by regressing the unique DEA scores on the attribute data. Reasons for using least squares and avoiding other

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distance measures are given. The method is tested on data where the true scores and weights are known.

The method enables the construction of an objective scoring formula which has been generated from the data arising from all assessed entities, and is in that sense, democratic.

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Data Science meets Optimisation

Boosting Efficiency and Accelerating Computation in Vehicle Routing: Expanding on ALNS via Local Optimisation and Parallelisation

Ms Louisa Sober[1]
[1]Datasparq

Parallel 4 - Data Science meets Optimisation, Room 4.16, September 13, 2023, 09:00 - 10:30

Biography:
Louisa is a Data Scientist at Datasparq with a background in Systems Biology and Logistics Optimisation

Creating a highly efficient, and competitive vehicle routing solution for a large fleet and multiple locations is a challenging endeavour. I will discuss how Datasparq have approached this task by constructing a vehicle routing algorithm that improves upon output quality whilst minimising computational time. Our methods for achieving this include expanding on the Adaptive Large Neighbourhood Search (ALNS) algorithm using local optimisation techniques and leveraging computational parallelisation.

ALNS serves as a powerful metaheuristic algorithm that optimises the selection of destroy/repair heuristics. It is able to explore vast solution spaces and avoid getting stuck in local optima, which is crucial given the scale of the problem encountered by national logistical networks. In conjunction with ALNS, we have implemented local-search algorithms. This is a well-matched combination of algorithms, as it allows for finer level improvements (such as the swapping two adjoining locations) alongside the broader scale changes facilitated by ALNS.

Furthermore, we integrated a parallelisation framework into ALNS to further enhance its performance. The original framework was designed with a destroy/repair weight update mechanism that required a single thread. However, we have extended this by implementing a parallelisation strategy for updating the weights. By utilising hundreds of CPUs, this approach allows us to deliver competitive solutions within a matter of hours.

In exploring these enhancements of the ALNS algorithm, the effects of these techniques on speed of computation and quality of output will be discussed in the context of insights from our collaboration with a multinational logistics company.

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Efficient Vehicle Routing for Delivery Day Balancing: Leveraging Call Clustering with ALNS Optimization

Mr Adil Rahman[1], Mr Kiko Rullan[1]
[1]Datasparq

Parallel 4 - Data Science meets Optimisation, Room 4.16, September 13, 2023, 09:00 - 10:30

Biography:
Hi, I'm Adil. I'm currently a Senior Data Scientist at Datasparq. I work across a wide range of Data Science projects but have recently been primarily focused on large scale vehicle routing optimisation problems. My background is in optimisation within the healthcare space. This includes resource allocation within tertiary care and space utilisation in healthcare spaces. Prior to entering the world of optimisation, I was a Software Engineer within the healthcare space. Some of my work included integration within national cancer screening systems within the NHS.

In this presentation, we showcase an ensemble algorithm that effectively balances calls across delivery days, developed in collaboration with a multinational logistics company.

The objective was to reduce serving costs within the delivery network while considering operational constraints, such as depot-level union agreements and resource limitations, including the available vehicle profiles.

The optimization process utilizes an Adaptive Large Neighbourhood Search (ALNS) algorithm, a metaheuristic approach that optimizes weights for various insertion and removal heuristics. To preprocess the data, we designed an ensemble algorithm that redistributes calls based on contiguous travel distance while maintaining constraints, such as maintaining similar payload weights throughout the days.

Initially, the ensemble algorithm queries each customer's postcode to determine their relative geographical location. It then calculates their convex hull to identify initial cluster locations that maximize the distance between delivery days. Using a greedy round-robin approach, each call is assigned to the nearest cluster to create the initial clusters.

To identify contiguous regions of geographical density, we employ the DBSCAN algorithm with a precomputed travel matrix. Finally, a heuristic is used to swap calls between neighboring contiguous regions to comply with business-level constraints. For example, calls are swapped to reduce the variance of weight delivery across delivery days without compromising on the distance traveled.

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This solution is generalized across different depots, and we have found that it effectively balances calls across delivery days in advance of our ALNS optimizer. While this solution is effective for depots of all sizes, the potential gains are higher for depots with a larger customer base that covers larger geographical areas, including concentrated urban regions. It was tested on large depots with over 2,000 calls.

Stackelberg Games for Adversarial Learning

Mr David Benfield[1], Dr Alain Zemkoho, Dr Vuong Phan, Dr Stefano Coniglio
[1]University Of Southampton

Parallel 8 - Data Science meets Optimisation, Room 4.10, September 14, 2023, 09:00 - 10:30

Biography:
David Benfield is a postgraduate research student in the Operational Research Group within the School of

Mathematical Sciences at the University of Southampton. He is in his second year, studying bilevel optimisation and, specifically, its applications to Adversarial Machine

Learning.

Adversarial machine learning concerns the situation where data miners face attacks from active adversaries. In particular, the underlying distribution of the data used by the data miner to train machine learning models is vulnerable to significant changes made by the adversary. The interactions between the data miner and the adversary can be modelled as a game between two players. While many game theoretic models exist, some of these assume that the players act simultaneously. However, in the case of adversarial learning, a perhaps more appropriate assumption is that players can observe their opponent's actions before making their own. For example, spam email senders might probe an email filter by sending test emails before deploying their final products. Furthermore, the amount of information available to each player can influence their decision process. We present a Stackelberg Game model where players act sequentially and which restricts the availability of information. In this Stackelberg model, the two players are each assigned a role of either the leader, who acts first, or the follower, who acts second. This gives us two possible approaches to modelling our adversarial scenario, depending on who takes on these roles. Focusing on the case where the data miner takes the role of the leader, we explore how pessimistic bilevel optimisation can be used to model adversarial learning scenarios before developing and testing a solution method.

Scalable Optimisation of a Dynamic Pricing Model

Mr Michael Sutherland[1], Ms Erika Gravina[1], Ms Ruby Stoddart[1]
[1]Datasparq

Parallel 8 - Data Science meets Optimisation, Room 4.10, September 14, 2023, 09:00 - 10:30

Biography:
This project was developed by a team at Datasparq, an experienced AI company focused on providing high quality ethical AI solutions to their clients. The team has a wide variety of experience and expertise in STEM including machine learning, quantum computing, and reinforcement learning.

Over the last year a team at Datasparq has been developing a scalable dynamic pricing model which leverages supervised machine learning, optimisation theory and parallel processing to effectively handle a highly complex market with multiple products available to consumers.

The solution tackles challenges such as the optimisation of strategies across year-long lead times, taking into account supply constraints and significant quality differences across products available. Due to the stochastic nature of the market, a model is defined to estimate the market reaction to prices, which is then utilised to create a simulated environment for a pricing agent to operate in.

With an embedded learning loop to enable continuous updating of the optimal strategies, this scalable dynamic pricing model has been deployed to recommend thousands of pricing recommendations on a daily basis.

How the National Audit Office is using process mining to gain insight and assurance into government operations

Mr Ben Coleman[1]
[1]National Audit Office

Parallel 8 - Data Science meets Optimisation, Room 4.10, September 14, 2023, 09:00 - 10:30

Biography:

Ben has led the National Audit Office's data analytics function since 2014. With 15 years prior experience as a statistician in a number of government departments, he is an expert in data modelling and the application of data analytics to audit and in various programming languages.

This presentation will showcase how the National Audit Office (NAO) is using process mining to gain insight and assurance into the work of government departments.

The session will begin with a brief introduction into the work of the NAO and to process mining as an analytical methodology - including the software and data required to utilise it effectively. The presentation will then introduce practical examples of how the NAO has used, and is intending to use, process mining to support both its important value for money and financial audit workstreams - some process mining outputs from recent NAO work will be presented. Finally, the presentation will describe recent work being done with several international audit offices to create a new process mining application, built with the Shiny package in R, which will serve to further standardise and streamline it's use as an effective audit technique.

Attendees will leave the session with a good understanding of what process mining is; how the NAO is effectively utilising it within it's work; and will hopefully be inspired to explore the technique as a tool for understanding and improving the operations of their own processes.

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Education in OR Analytics

To develop an awareness about business sustainability challenges in OR classrooms. A Challenge-based learning approach

Dr Eliseo Vilalta-Perdomo[1]
[1]Aston University. Aston Business School

Parallel 5 - Education in OR Analytics, Room 4.16, September 13, 2023, 10:50 - 12:20

Biography:
Senior Teaching Fellow and co-director of the Community Resilience and Sustainability Education Lab (CoRSEL) at Aston Business School, Aston University, United Kingdom. He holds a PhD in Business and Management Systems awarded by the University of Lincoln, United Kingdom, and a BSc in Industrial and Systems Engineering and an MSc in Manufacturing Systems from Tecnológico de Monterrey, Mexico. Previous academic experience includes being Associate Professor in Operations and Logistics Management at Lincoln International Business School, University of Lincoln (2011-2020). He has also been a part-time Lecturer (1993-1999) and full-time academic (2000-2011) at Tecnológico de Monterrey, where he was Associate Professor, Head of the Department of Industrial & Systems Engineering (Campus Guadalajara), and Dean of the Division of Higher Education (Campus Irapuato). Eliseo has been involved in developing and implementing CBL initiatives since 2009 and has been coordinating a CBL pilot project financed by the EU Interreg Sea North Region Fund (2019-2022). He has been recognized with the Nigel Slack Teaching Innovation Award 2020 by the European Operations Management Association due to his latest work on challenge-based learning. He has also been awarded a Doctorate Honoris Causa by Universidad Privada Antenor Orrego, Peru, and fellowships by the Advance HE (former Higher Education Academy), the Chartered Institute of Logistics and Transport, the Cybernetics Society, and the Operational Research Society. He was co-editor of The Emerald Handbook of Challenge Based Learning.

A series of Challenge-Based Learning (CBL) interventions were designed with the aim of developing working skills for undergraduate students. These CBL interventions were implemented in a UK university, where 300+ undergraduate business students provided their views after participating in this exercise. The results indicate that CBL is useful for this task. It is also an effective approach to developing soft skills such as collaboration, communication, planning and problem-solving. A framework to implement CBL in an Operations Management/Research module is offered.

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The inclusion and elimination of analytics in higher education – does it leave a skills gap?

Dr Samantha Buxton[1], Dr Tegwen Malik[1]
[1]Swansea University

Parallel 5 - Education in OR Analytics, Room 4.16, September 13, 2023, 10:50 - 12:20

Biography:

Dr Samantha Buxton is a Senior Lecturer in the School of Management at Swansea University. Her PhD focused on forecasting the lifecycle of branded and generic pharmaceuticals using GP prescription data. This links with her main quantitative data analysis research interests. Samantha's research has now taken a more pedagogical focus looking at student engagement and retention, assessment and feedback and team teaching from a quantitative perspective

Over the years, it has been noticed that business schools go through phases where there is an inclusion of analytics (including maths and statistics) in Business Management programmes and a subsequent exclusion. The inclusion process introduces analytics from a first-year undergraduate perspective, with the aim to bring all students to similar levels of analytics knowledge before expanding on this in later years. However, there has been a recent trend whereby some business schools remove analytics module options to the point where students can graduate from a 3-year undergraduate business management degree with no analytic literacy. Whilst the same is also true at postgraduate and PhD levels, these are generally specialist programmes where this is less of an issue. This issue is further compounded by the fact that many academics of business schools do not specialise in quantitative data analysis (in part due to not gaining this experience and skill from their own previous degrees) and hence it is easier to exclude such options from programmes. Thus, leaving a skills gap when going into industry or staying in academia. This is worrying considering analytic literacy is becoming an increasingly required skill within industry. This is an exploratory research paper that aims to explore the inclusion and elimination of analytics in relation to the skills gap of those staying in academia versus those going into industry. The research will use a grounded theory approach using both quantitative and qualitative data collection and analytics techniques with a dual focus. The first is to explore the skills gap of those going into industry compared with those staying in higher education. The second would be to propose potential solutions to the issue.

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Reflections on the impact of the Covid 19 pandemic on the design and delivery of OR & Analytics teaching

Dr Frances O'brien[1], Dr Kathryn Hoad[1]
[1]Warwick Business School

Parallel 5 - Education in OR Analytics, Room 4.16, September 13, 2023, 10:50 - 12:20

Biography:

Katy is an Associate Professor within the Operations Group at Warwick Business School, University of Warwick. She teaches across a number of student groups and subject areas including Business Analytics and Discrete Event Simulation

The purpose of this talk is to reflect on the impact of the Covid 19 pandemic on the design and delivery of OR & Analytics teaching at Warwick Business School across a number of modules and student groups.
We begin by outlining the design of four modules (Business Analytics, Simulation, OR for strategic planning, Modelling and analytics for management) taught to three cohorts of students (undergraduate, specialist masters and MBA).
We present a summary of how the delivery of teaching and module design changed over three time-zones, pre covid, during covid and post covid and reflect on the pedagogic decisions made. In particular we review the use of technology to support teaching design and delivery and the impact on delivering robust and appropriate assessments. We also explore the use of group work in technological settings and the notion of resilience in module design and delivery.
We finish with reflections on the design and delivery of these modules moving forward.

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Navigating the Frontier: Teaching Business Data Analytics in the Era of Large Language Models

Dr Heather He[1]
[1]Bangor University

Parallel 8 - Education in OR Analytics, Room 4.8, September 14, 2023, 09:00 - 10:30

Biography:
Heather is a Lecturer in Data Science/Analytics at the Bangor Business School, Bangor University, UK. Prior to this position, Heather was a doctoral researcher at the Centre for Risk Research, University of Southampton, UK. Her research interests are so far focused on (i) applied data science for finance & business analytics, (ii) behavioural risk-taking & decision-making, and (iii) financial technologies. Heather's research work has been presented at international conferences and workshops, including INFORMS and ACM International Conference on AI in Finance (ICAIF). Heather also serves as a reviewer for several internationally leading academic journals. Heather has interests and a track record in developing and delivering data science and business analytics programmes at undergraduate and postgraduate levels.

As the landscape of data analytics evolves, the inception of large language models, such as ChatGPT, poses both challenges and opportunities for pedagogical development in higher education. This paper encapsulates my experience and insights from developing a module entitled "Coding for Business Applications" at a UK university business school.

The evolution of AI technologies like ChatGPT demands an innovative approach to teaching data analytics. One of the primary challenges faced is maintaining the relevance of curriculum content amid rapid technological advancements. Students must grasp not only the foundational theories of data analytics but also the operational nuances of dynamic tools like ChatGPT. Thus, ensuring a curriculum that is both theoretically robust and technologically contemporary poses a significant challenge.

Additionally, the high level of automation provided by ChatGPT threatens to reduce the necessity for conventional coding skills. This necessitates a pedagogical shift towards understanding and manipulating AI outputs, effectively questioning and refining the information produced by these models.

Nevertheless, the advent of ChatGPT also brings transformative opportunities. As an educational tool, it can be used to demonstrate the application of advanced data analytics, language processing, and predictive modelling in real time. It has the potential to enhance

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student engagement and learning outcomes by offering an interactive environment for problem-solving and conceptual understanding.

Embracing this dual role of ChatGPT – both as a subject of study and as an educational tool – is crucial. To thrive in this transformative period, we must focus on nurturing a curriculum that encourages critical thinking, adaptability, and lifelong learning. An approach which prepares our students for the evolving frontier of business analytics and which utilises AI to enhance learning promises a resilient and thriving future for education in operational research analytics.

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The Impact of AI Text Generators in Enhancing Critical Thinking Skills among UK Business School Postgraduate Students

Dr Aniekan Essien[1], Dr Marios Kremantzis[1], Dr Teslim Bukoye[2], Dr Christine O'Dea[3]
[1]University of Bristol, [2]University of Bath, [3]Huddersfield Business School at University of Huddersfield

Parallel 8 - Education in OR Analytics, Room 4.8, September 14, 2023, 09:00 - 10:30

Biography:
Dr Aniekan Essien is a Lecturer (Assistant Professor) in Business Analytics in the School of Management at the University of Bristol Business School, teaching in the areas of Data Analytics in business, Operations, Supply Chain Management, Information Systems/Technologies in Supply Chains, and Management of Innovation. His research mainly concerns the application of data analytics using deep learning and artificial intelligence, data analytics and data science towards providing support for decision making that contributes to actualising positive improvements in business organisations. Dr Essien is an AI / Machine Learning researcher and data scientist with a passion for actualising change and creating impact using technology.

This study investigates the impact of AI text generators, such as ChatGPT and Perplexity AI, on enhancing critical thinking skills among UK business school postgraduate students. Given the mixed opinions on AI's role in higher education, there is a need for empirical research specifically addressing the effects of AI text generators on critical thinking skills development. Drawing on Bloom's taxonomy as the theoretical framework, this study employs a mixed-methods research design, combining a quasi-experimental pre-test and post-test approach with semi-structured interviews. Participants will be divided into a control group and an experimental group, with the latter using AI text generators as supplementary tools. Quantitative data from the pre-test and post-test will be analysed using statistical tests, while qualitative data from interviews will undergo thematic analysis. The expected outcomes of this study aim to provide insights into the potential impact of AI text generators on developing critical thinking skills and may inform strategies for leveraging AI technologies to benefit student learning and academic success in higher education.

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Designing Active Learning Business Analytics Sessions with Team-Based Learning approach

Dr Marios Kremantzis[1]
[1]Business School, University of Bristol

Parallel 8 - Education in OR Analytics, Room 4.8, September 14, 2023, 09:00 - 10:30

Biography:

Marios Kremantzis is a Lecturer (Assistant Professor) in Business Analytics and Deputy Programme Director in MSc Business Analytics at the University of Bristol Business School.

Marios' research interests lie in the fields of optimisation, Data Envelopment Analysis (DEA), efficiency measurement, and multi-criteria decision analysis. He has substantial experience in building and applying mathematical models to understand what the data is saying and then creating real-world solutions. Thanks to various cross-disciplinary research collaborations, his work has already been published in the prestigious ABS journals of Expert Systems with Applications, Socio-Economic Planning Sciences, RAIRO-Operations Research, Agriculture, and IJFSD. He has also organized special sessions for the internationally renowned conferences of the Operational Research Society, DEA45, and the Athens Institute for Education and Research. During his doctoral studies, he received funding from the Engineering and Physical Sciences Research Council and the BAE Systems, and he has taken part in internationally renowned conferences and workshops in the UK, Greece, and South Korea.

Furthermore, Marios is the Founder and Chair of the OR, Analytics & Education SIG within the OR Society and a Fellow of the Higher Education Academy (FHEA). He is an Associate in the theme of designing active learning sessions at the Bristol Institute for Learning & Teaching. He has distinguished himself for innovative teaching and authentic assessment practices (Chatbot, Team-Based Learning), which led to his nomination for 2022's Bristol Teaching Awards: "Inspiring and Innovative Teaching Award – Individual" and "Outstanding Personal Tutoring Award – Individual". Previously, the University of Southampton awarded him (Doctoral College Director's Award 2021) in recognition of his exceptional contribution to teaching and learning in both physical and online environments.

In this short presentation, we will look at the Team-Based Learning (TBL) approach, which is a powerful way of peer learning. We will understand how the TBL has been put into practice

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to further engage students and help them become even more familiar with the course material to successfully solve problems. In particular, we will explore the 4-step Readiness Assurance Process to which TBL relies upon; this is implemented to ensure that learners are motivated to make preparation before class and then turn it into true readiness to cope with MCQ and application case studies/exercises during the class. I will make a demonstration of a cloud-based web application (InteDashboard) for TBL quizzes and cases and explain how to make the most out of it to enhance student engagement.

Facility Location

Humanitarian supply chain planning: the effect of location decisions on fair allocations of donations

Francisco Saldanha-da-Gama[1], Zehranaz Dönmez, Bahar Y. Kara, Dr Özlem Karsu
[1]Sheffield University Management School

Parallel 7 - Facility Location, Room 3.1, September 13, 2023, 17:00 - 18:00

Biography:
Francisco Saldanha da Gama is professor of Supply Chain Management at Sheffield University Management School. He has a large teaching experience both in terms of undergraduate and post-graduate programs. He has published extensively in scientific international journals, and he has co-edited the two editions of the "Location Science" published by Springer International Publishing. He has presented more than 150 contributed talks at scientific events being invited to innumerable scientific events as a plenary/semi-plenary/keynote speaker. He has been awarded several prizes and honors. He is a member of various international scientific organizations such as the INFORMS, the European Chapter on Combinatorial Optimization, the Working Group on Stochastic ptimization, and the EURO Working Group on Locational Analysis of which he is one of the past coordinators. Currently, he is the Editor-in-Chief of Computers & Operations Research as well as a member of the Editorial Advisory Board of the Journal of the Operational Research Society (UK), Operations Research Perspectives, Algorithms, and Social Sciences & Humanities. His research interests include Supply Chain Management, Logistics, Decision-Making under Uncertainty, and Project Management.

One important problem in the aftermath of a disaster event consists of finding a fair distribution of a scarce relief item among different demand points (e.g., shelter sites) requiring such item. This can be accomplished by using a set of facilities called points of distribution that are often mobile. The relief item is then shipped to such facilities and collected in there by someone representing the demand points. Time plays an important role in this problem since relief items often depend on donations and thus their supply varies throughout time. Two major decisions are to be made for all periods of a finite-length planning horizon: (i) where to locate a limited number of mobile points of distribution and (ii) what quantity to deliver to each demand node (possibly less than the demand). In search for fair solutions, three criteria are considered. The first two involve a so-called deprivation cost, which is a measure of the "suffering" of a population for facing shortage of the relief item. The third objective is related with travel time or distance for reaching the demand

nodes throughout the planning horizon. A modeling framework is proposed for the problem. The two resulting vectorial optimization models can be solved using the classical epsilon-constrained method. Computational results are presented that result from applying the methodological developments proposed to an instance of the problem using a mixed data structure consisting of real and generated parts.

A Soft-Constrained Multi-Objective Facility Location approach to design Household Waste Recycling Centres networks

Dr Antonino Sgalambro[1], Dr Serena Fugaro, Dr. Filippo Santarelli
[1]Sheffield University Management School

Parallel 7 - Facility Location, Room 3.1, September 13, 2023, 17:00 - 18:00

Biography:

Dr Antonino Sgalambro is a Senior Lecturer in Operations Research and Supply Chain Management at the Sheffield University Management School. He is a Senior Fellow of the Higher Education Academy and holds a PhD in Operations Research from the University of Rome "La Sapienza". His research focuses mainly on Operations Research, Optimisation, Logistics and Supply Chain Management, Decision Support Systems.

Efficient Waste Management represents a key point of the 25 Year Environment Plan devised by the UK government in 2018. In this context, the location of collection and recycling facilities for municipal waste plays a crucial role in achieving governmental recycling rate goals. However, economic pressure and elevated running costs are leading UK local authorities to re-organise the Household Waste Recycling Centres (HWRCs) networks. Local authorities are often interested to explore different configurations for their HWRC networks, aiming at reducing operating costs and achieving higher levels of user satisfaction, whilst meeting specific service level and quality requirements.
In this work we present a novel Multi-Objective Facility Location Problem in Waste Management, tailored for the design of HWRCs networks, and aimed at formalising several specific underlying real-world problem requirements. Additionally, to secure an accurate representation of the actual dynamics that drive the HWRCs network design process, we devise a soft-constrained version of the resulting problem. The arising Pareto Sets are explored efficiently by adopting the robust variant of the AUGMEnted ε-CONstraint method (AUGMECON-R). The computational characterisation of the proposed model is provided by adopting benchmark instances from real-world case studies, and valuable managerial insights are derived from the analysis of the numerical experiments results.

Forecasting

Challenges of medium-term air passenger demand forecasts within the airline industry

Dr Craig Poku, Dr Michèle Pettinato[1], Dr Judit Guimera-Busquets[1]
[1]Datasparq

Parallel 2 - Forecasting, Room 3.9, September 12, 2023, 13:15 - 14:45

Biography:
Dr Michèle Pettinato has a background in clinical Speech Science and has worked for several years in industry. She has both applied her background to NLP and audio project as well as branched out into new domains, with recent forays into forecasting and demand modelling. She particularly values multi-disciplinary approaches and is excited by projects which encompass solid real-world evaluations of models and technical applications.

Medium- term forecasts are key for business planning within the airline industry but a significant challenge to generate. It enables planning ahead of time and airlines will use them to make strategic decisions on network changes and plan for the future changes on demand. Failing to do so may end up not only in high economic losses but also have an impact on the socioeconomic development of countries and regions. One of the main challenges we face is that these models are difficult to evaluate during their development due to the gap between the time of a prediction and its target date. This challenge has worsened due to the pandemic, leaving a gap of around 2-3 years of unusable data.
We present a case study of developing a medium-term forecast for a major European airline that looks at 1-2 years time horizon at flight level. Our talk examines the arc of development of such a complex project and discusses a number of topics which were relevant to this undertaking: 1) When developing a solution where previously no tool existed within a business, it can be challenging to establish optimal evaluation criteria which address the needs and questions of all stakeholders. 2) With a project of this size, there is tension between quick and easy experimentation and building an architecture which is able to support this experimentation with large amounts of data. 3) Operational aspects of the business may interact with the building of a medium-term forecaster in unexpected ways: how to anticipate and integrate these challenges. 4) Aspects of feature and model architecture. 5) Finally, we consider monitoring for model drift and continuous training.

Scalable Gaussian processes for multi-output forecasting of distributed solar power generation

Dr Astrid Dahl[1]
[1]Datasparq

Parallel 2 - Forecasting, Room 3.9, September 12, 2023, 13:15 - 14:45

Biography:
Dr Astrid Dahl is a data scientist with Datasparq, London, and has worked in data science and machine learning research for the last nine years. Her focus is on high dimensional forecasting, especially for energy applications. She completed her PhD at the University of New South Wales (Computer Science) in scalable Bayesian nonparametric methods.

Dr Dahl also has a background in econometrics where (in a previous life) she worked on economic modelling problems in energy, finance and agriculture.

As small-scale distributed solar grows in importance (in Australia, more than 1 in 3 houses have solar panels), forecasting problems around solar and other non-dispatchable generation are becoming more and more relevant for use cases such as storage optimisation and local grid control.
Gaussian process (GP) models are a powerful class of probabilistic methods that have wide application in spatiotemporal modelling. However, they come with well-known challenges when scaling up to real-world applications due to model complexity. This talk will present several 'workhorse' variations of GP models for multi-output forecasting and apply them to the case of distributed solar power. The talk will cover some of the challenges with large scale implementation and the advantages and limitations of these models from a practical perspective.

Transforming Emergency Department Operations: A Study on LSTM-Based Patient Arrival Forecasting

Mr. Mingzhe Shi[1]
[1]Cardiff business school

Parallel 2 - Forecasting, Room 3.9, September 12, 2023, 13:15 - 14:45

Biography:

PhD. student of Logistics and Operations Management at Cardiff University, UK

Supervisors: Dr Bahman Rostami-Tabar, Dr Daniel Gartner

Research project: Improving the unscheduled planning in urgent and emergency care: Using predictive modelling to deliver quality care.

- *Understand the source of uncertainty in demand and service in patient flow throughout the system.*

- *Create an integrated modelling framework to optimise the allocated resources by generating accurate forecasts tailored to decision-making.*

- *Develop deep learning and machine learning approaches to provide probabilistic forecasting and planning to embrace uncertainty in unscheduled care.*

This study focuses on accurately forecasting patient arrivals at Emergency Departments (EDs), a critical factor in resource allocation and patient flow optimisation. We employ a Long Short Term Memory (LSTM) model to predict patient demand, with a granularity of 15-minute intervals and a one-day-ahead prediction window. For comparison, we use seasonal naive and exponential smoothing models as benchmarks. The model's accuracy is evaluated using Root Mean Square Error (RMSE) and Mean Absolute Error (MAE). We utilise a dataset spanning four years for model training and a separate one-year dataset for testing, with one-day-ahead cross-validation to ensure robust results. Our findings suggest that the LSTM model outperforms the benchmarks, providing valuable insights for decision-makers in optimising ED operations.

Intermittent Demand Forecasting for Final Purchase Decisions

Miss Robyn Goldsmith[1], Professor John Boylan, Dr. Anna-Lena Sachs
[1]Lancaster University

Parallel 10 - Forecasting, Room 4.8, September 14, 2023, 14:30 - 16:00

Biography:
Robyn is a PhD Student at the Statistics and Operational Research Centre for Doctoral Training in partnership with industry (STOR-i) at Lancaster University.

Across a number of sectors, after-sales services constitute a billion-dollar business. Final purchases are high stake decisions of particular importance for the aftermarket business. They are often made towards the end of the spare part life cycle and need to balance shortages and over-ordering so as to sustain demand for the rest of a part's life. In the automotive industry, among others, this period can extend for as long as ten years.

Forecasting in order to make effective final purchase decisions is made difficult by the nature of the demand. A large majority of spare part inventories consist of items with intermittent demand structures, where in some periods no demand is observed at all. As a result, standard forecasting methods provide inaccurate forecasts for intermittent items. As final purchase decisions are frequently made to sustain demand several years into the future, modelling procedures should also be designed to include the decay in demand as time passes. A forecasting model that accounts for aspects of both decline and the intermittency of demand are the subject of this talk.

Forecasting and demand planning in the presence of disruptions

Ms. Ritika Arora[1], Professor John Boylan[1], Dr. Anna-Lena Sachs[1]
[1]Lancaster University

Parallel 10 - Forecasting, Room 4.8, September 14, 2023, 14:30 - 16:00

Biography:
Ritika Arora is a PhD student and is working on demand forecasting and planning in the presence of disruptions. Her research will later extend to ordering and inventory management during such disruptions.

In recent years, retail companies have experienced several disruptions with potentially large effects on demand, supply, or both. For example, companies in the UK were subject to supply issues, delays due to Brexit, Covid-19 and lockdowns. During these times, many decision makers are operating in unknown terrain and retail forecasting systems they use during normal times do not provide reliable estimates. Being able to still forecast demand as accurately as possible during disruptions and also afterwards if data has been distorted is crucial for businesses to be successful. We propose a shock-smoothing approach to forecasting and demand planning in the presence of disruptions, with an emphasis on improving forecasting performance. We compare our approach to standard and adaptive methods from the literature to show when it outperforms existing methods. Our approach is suitable to help demand planners make data-driven decisions by estimating and planning for demand during and post disruptive events.

Keywords: retail forecasting, shock smoothing, supply chain disruption, demand forecasting.

What is the value of congruous forecasts across time?

Dr Kandrika Pritularga[1], Professor Nikolaos Kourentzes
[1]Lancaster University

Parallel 10 - Forecasting, Room 4.8, September 14, 2023, 14:30 - 16:00

Biography:
Kandrika is a lecturer in management science at Lancaster University. His expertise is in business and healthcare forecasting, specifically in managing uncertainty and hierarchies.

Forecasts of future demand are necessary for inventory management. Typically, the focus is on producing accurate forecasts, which are desirable in the statistical sense. On the other hand, the limited work that looks jointly at forecasting and inventory control has identified low out-of-sample bias to be more important than accuracy. Shrinkage estimators and forecast combination shift the attention from in-sample fit to better generalization in the future. These result in less volatile forecasts, with typically better predictive distributions, specifically at quantiles of interest, and less out-of-sample bias. Moreover, companies often prefer forecasts that may be suboptimal in the statistical sense, but change less across time periods, putting less strain on production planning and inventory management, even though this may harm accuracy, attempting to minimize total costs. Arguably this increased congruous forecasts across time periods points to a different objective than accuracy. This is also reflected in recent views on forecast evaluation, where metrics closer to the relevant decision making are seen as desirable, albeit difficult to operationalize, and has been speculated to relate to the trustworthiness of forecasts.

In this work we investigate the impact of increased congruous forecasts across time periods in terms of forecasting, and supported decisions, such as inventory management. We do this by employing a variety of approaches that can decrease the volatility of forecasts across origins: shrinkage and M-estimators, and forecast combination. We simulate the inventory position of a company, investigating the connection between the incurred costs, forecast congruity, bias, and accuracy. Our objective is to characterize the trade-off, to support better specification of forecasting models in the application context, while potentially avoiding relying on difficult to operationalize performance metrics.

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Hybrid Modelling and Simulation

Exploring the potential of design of experiments techniques in discrete-event simulation

Miss Amalia Gjerloev[1], Dr. Guillaume Lamé[2], Dr Luca Grieco[1], Professor Sonya Crowe[1]
[1]Clinical Operational Research Unit, University College London, [2]Centrale Supélec, Université Paris Saclay

Parallel 3 - Hybrid Modelling and Simulation, Room 3.15, September 12, 2023, 14:45 - 15:45

Biography:
Amalia has a background in both physics and mathematics. After completing her BSc at the University of Richmond, she took time off from academia and worked at a healthcare software company for two years. There, she worked closely with several health care organizations in regards to patient movement and financial assistance. In 2020, she completed her MSc in physics at Imperial College of London with a focus on astrophysics. During her PhD, she has worked to combine her knowledge of electronic health record systems (EHRS) with operational research techniques to improve NHS services. Her research focuses on using simulation techniques to improve patient flow through cancer pathways.

Design of Experiments (DoE) is a branch of applied statistical methods, sometimes referred to as experimental design, that aims to efficiently assess the impact of input parameters on a system's responses. DoE covers a range of techniques including robust experimental designs, response surface methodology, and sensitivity analysis. These techniques provide an opportunity to gain insight into the effect of a model's parameters, which in turn can help modellers and end-users better understand the system under different scenarios. While potentially useful for a better understanding of the interplay between different parameters in discrete-event simulation (DES) models, DoE is rarely used in such contexts. We conducted a review of the literature and identified 60 papers that used DoE techniques to analyse DES models. The majority of these articles applied simple DoE techniques, namely full-factorial designs, to case studies. However, more advanced methods have also been combined with DES, both in methodological and applied articles. In this talk, we will present the results of our literature review. Furthermore, we will describe our attempt at devising a step-by-step methodology for selecting and incorporating the most appropriate DoE techniques into DES model analysis, accounting for problem-types and envisaged insights.

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Hybrid Modelling & Simulation, Digital Twins and Artificial Intelligence - A Synergy to Support Dynamic Strategic Thinking in Times of Uncertainty

Mr Lambros Viennas[1], Dr Masoud Fakhimi[1], Dr Christopher Turner[1]
[1]University Of Surrey
Parallel 3 - Hybrid Modelling and Simulation, Room 3.15, September 12, 2023, 14:45 - 15:45

Biography:
Lambros Viennas is an Operational Research practitioner and PhD Student. He holds a BSc in Computer Information Systems and an MSc in Management Science and Operational Research. He is currently studying in his second year as a part-time PhD student at the University of Surrey Business School.

Lambros undertook several roles predominately in the Aluminium Rolling sector in his professional life spanning three decades in the Manufacturing Industry. In the past twenty years, he has resided in the West Midlands (UK), where he currently works as the Manufacturing Excellence Manager in a major Flat Aluminium products facility.

His research interests include Simulation Modelling, Problem Structuring Methodologies, Data Intelligence and Strategic Thinking and Management.

In fast-paced industries with rapidly evolving technologies, organisations require management models that are both simple and adaptable, enabling them to prioritise critical aspects for their operations, competitiveness, and survival. Modelling and Simulation (M&S) techniques have demonstrated their effectiveness in addressing complex decision-making problems within dynamic and complex contexts. As systems continue to increase in complexity, M&S researchers and practitioners increasingly embrace Hybrid M&S.

Hybrid M&S involves the integration of methodologies from various subject areas, such as systems thinking, data science, or computer science, with conventional M&S practices. The objective is to leverage the synergies achieved by combining M&S with cross-disciplinary methods, resulting in a unified approach that enhances the overall modelling process.

In recent years, Hybrid M&S, in conjunction with advanced technologies like Digital Twins, Artificial Intelligence, and Machine Learning, has been implemented in Intelligent Production Systems within the Manufacturing industry. This integration empowers companies to optimise their operations, adhere to best practices, improve resource and

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asset management, and achieve growth, competitiveness, and profitability by minimising wastage.

This study examines existing literature to explore cases where M&S and Digital Twins are jointly employed. Utilising the Dynamic Capabilities framework and conducting a comprehensive review of twenty-seven relevant papers, this research aims to provide an in-depth understanding of the current state-of-the-art in Hybrid M&S, particularly regarding the capture of dynamic capabilities. The analysis considers the dynamic nature of organisations, viewing both tangible and intangible assets within the modelling context and the implemented solutions, whether they are conceptual or empirical. By doing so, the study contributes to the development of an organisation's dynamic capabilities, sustains competitive advantages, and facilitates adaptation to rapid organisational changes. Furthermore, the study critically evaluates the limitations present in the existing Hybrid M&S literature and suggests potential areas for further research in this field.

Promoting resilience within the pharmaceutical supply chain: A hybrid simulation approach

Mrs Fatemeh Alidoost[1]
[1]University of Exeter

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
MRes Management

The pharmaceutical supply chain (PSC) is a complex network, spanning multiple stakeholders and global systems. Medicine and vaccine shortages have risen worldwide due to multi-factorial causes including supply-related factors (e.g., manufacturing issues, logistics, and distribution) and demand-related factors (e.g., fluctuations in demand, price). Extraordinary geopolitical events (e.g., sanctions and Brexit) and different disruptions (pandemic, natural disasters, etc.) can also affect medicines' availability and PSC resilience. The Coronavirus pandemic exacerbated these challenges in many countries and has had significant consequences on the healthcare system including delays in treatment and cancellation of care. Insufficient, missed, or postponed medical care can lead to unfavourable consequences for patients and considering the UK health system (publicly funded healthcare system), a greater system cost might be incurred.
Modelling and Simulation (M&S) techniques such as Discrete-Event Simulation, Agent-Based Modelling and System Dynamic are widely applied in different areas including supply chain and healthcare. Further, advances in computing power have potentially increased the possibility of developing more realistic models. While healthcare problems are characterised by multiple interconnected factors that create a complex network, these complexities are challenging to capture and represent through one single M&S method. Hybrid simulation modelling frameworks allow for the combination of different simulation methods to create a more comprehensive model that can capture the complex interactions and dependencies within the PSC. This approach enables the model to be more flexible and adaptable, allowing for the inclusion of different types of data and the exploration of different scenarios.
In this study, a hybrid simulation modelling framework of the PSC is proposed to investigate the interrelation between different levels of the SC during a disruption such as the recent pandemic. The proposed model will investigate the critical bottlenecks of the PSC during a disruption as well as aid the evaluation of the cost-effectiveness of different interventions in response to the disruption to support decision-making processes.

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The NHS Urgent Cancer Referral Pathway for suspected urological cancers: early economic evaluation of a risk prediction test

Dr Paola Cocco[1], Dr Alison Smith, Professor Richard Neal, Professor Bethany Shinkins
[1]University Of Leeds

Parallel 8 - Hybrid Modelling and Simulation, Room 3.9, September 14, 2023, 09:00 - 10:30

Biography:

Paola works as a Research Fellow at Academic Unit of Health Economics (AUHE) at the University of Leeds. She mostly works on projects related to test evaluation, specifically projects related to new diagnostic and screening tests.

Paola had previously joined AUHE in 2018 as a Postgraduate Researcher in Health Economics. Her PhD project focused on integrating early economic modelling into the development

process of Target Product Profiles for diagnostic tests. Paola applied the early economic modelling to derive necessary performance requirements new rapid tests for Clostridium difficile infection should possess based on cost-effectiveness considerations. Paola developed a resource-constrained discrete event simulation models to capture the main activities and processes patients face while waiting for their diagnosis of CDI up to discharge.

Background: In the UK, the number of patients urgently referred for cancer is increasing and providers are struggling to cope with demand. The majority do not have cancer, providing an opportunity to prioritise urgent referrals for those at highest risk. We explore the potential costeffectiveness of a new blood-based risk prediction test – the PinPoint test – to prioritise patients referred with suspected urological cancers.

Methods: Two resource-constrained discrete event simulation models were developed in SIMUL8 to reflect the diagnostic pathways for patients with suspected prostate cancer, and bladder or kidney cancer, comparing PinPoint test to current practice. Model parameters are taken from observational data, published literature and expert opinion. An early economic analysis was conducted from a UK NHS perspective. The primary outcomes were the percentage of individuals meeting the two-week wait (TWW) target and heath care costs. The volume of referrals and current waiting time performances were varied in the analyses. An exploratory analysis was conducted to understand the potential impact of the Pinpoint test on life years gained.

Results: Across both models and all volume and performance scenarios, the PinPoint test led to more individuals with urological cancer being seen within two weeks. The per-patient cost of the PinPoint pathway increased due to the cost of the test. The exploratory analysis

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indicated that there could be a marginal improvement in 10-year survival for patients with urological cancer across all scenarios.

Conclusion: Using the PinPoint test to prioritise urgent referrals for suspected urological cancer meant that more individuals with cancer were seen within two weeks, for an increased cost to the NHS.

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What necessary properties should a hypothetical rapid test for Clostridioides difficile infection possess? An early-stage resource-constrained discrete simulation model and cost-effectiveness analysis informing a Target Product Profile

Dr Paola Cocco[1], Dr Alison Smith, Dr Kerrie Davies, Dr Christopher Rooney, Professor Robert West, Professor Bethany Shinkins
[1]University Of Leeds

Parallel 8 - Hybrid Modelling and Simulation, Room 3.9, September 14, 2023, 09:00 - 10:30

Biography:
Paola works as a Research Fellow at Academic Unit of Health Economics (AUHE) at the University of Leeds. She mostly works on projects related to test evaluation, specifically projects related to new diagnostic and screening tests.

Paola had previously joined AUHE in 2018 as a Postgraduate Researcher in Health Economics. Her PhD project focused on integrating early economic modelling into the development

process of Target Product Profiles for diagnostic tests. Paola applied the early economic modelling to derive necessary performance requirements new rapid tests for Clostridium difficile infection should possess based on cost-effectiveness considerations. Paola developed a resource-constrained discrete event simulation models to capture the main activities and processes patients face while waiting for their diagnosis of CDI up to discharge.

BACKGROUND: Clostridioides difficile infection (CDI) is a healthcare-associated infection which causes diarrhoea. In the UK, inpatients with suspected CDI are typically isolated in single rooms while awaiting test results to prevent transmission. A rapid test for CDI is under development as part of a Medical Research Council-funded programme grant (MR/N029976/1). To ensure that the test is 'fit-for-purpose', a Target Product Profile (TPP) will be developed outlining the necessary characteristics of the test.TPPs are strategic documents, targeted at test developers, summarising at early development stages the key properties tests should possess in order to fulfil an unmet clinical need. Within TPPs, the performance specifications are typically labelled either acceptable or desirable based on literature and expert opinion.

OBJECTIVES: To inform the TPP for rapid POCT for CDI, this study has the following objectives
1. To map the typical care pathway for CDI.

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2.To explore the impact that a hypothetical POCT could have on infection control infrastructure, clinical decision-making, infection spread and costs.
3.To identify the necessary characteristics of a POCT for CDI to be cost-effective compared to standard care from a UK NHS perspective.

METHODS: An early economic model, consisting of a resource-constrained discrete event simulation model, was developed in SIMUL8 reflecting the Leeds Teaching Hospitals NHS Trust (LTHT) care pathway for patients with suspected CDI. The model compares the hypothetical test against the standard care testing at LTHT over a seven-month time horizon. A three-phase de novo framework was developed to derive minimum performance specifications (diagnostic sensitivity and specificity) and maximum price based on cost-effectiveness considerations and to test their robustness using a series of sensitivity analyses.

RESULTS: In the case of a new rapid test for CDI, a minimum diagnostic sensitivity of 96% and diagnostic specificity of 96% is required to maintain cost-effectiveness. A maximum threshold cost would be approximately £44, whereas the headroom cost would be £554.

CONCLUSIONS: Modelling results were used as a means of informing minimum performance specifications, while also accounting for the (inevitable) uncertainty surrounding the minimum performance requirements.

Unleashing the Potential of Hybrid Simulation in Healthcare

Mr Eyup Kar[1], Dr Masoud Fakhimi[1], Dr Christopher Turner[1], Professor Tillal Eldabi[2]
[1]University Of Surrey, [2]University of Bradford

Parallel 8 - Hybrid Modelling and Simulation, Room 3.9, September 14, 2023, 09:00 - 10:30

Biography:
Eyup Kar is a PhD student at the Department of Business Transformation at the University of Surrey. His research topic is hybrid simulation modelling in healthcare.

In recent years, Hybrid Simulation (HS) has emerged as a prominent methodology, particularly in the healthcare domain, in response to the increasing multidimensionality and complexity of problems. HS integrates multiple simulation techniques, including Discrete-event, Agent-based, and System Dynamics, into a unified approach, presenting a promising solution to address these challenges. By leveraging HS, a comprehensive and holistic perspective can be achieved, enabling the capture of intricate intricacies and interdependencies within the healthcare system across strategic, individual, and operational levels.
In light of the potential benefits offered by HS, the lack of clear guidelines for the model development process presents a hindrance to its effective adoption and utilization in healthcare. To address this gap, a comprehensive step-by-step model development framework is essential, placing emphasis on crucial aspects such as problem statement definition, understanding relevant data sources, and appropriate modelling technique selection. The aim of this research is to propose a HS framework to guide modellers through the process of data collection, data pre-processing, and model construction, while highlighting key decisions and considerations at each stage.
The proposed framework would outline best practices, recommend methodologies, and provide a structured approach to address the unique challenges encountered within healthcare systems. By establishing such standardised guidelines, the healthcare community can cultivate a common understanding and language when it comes to HS in healthcare. This, in turn, would facilitate collaboration, knowledge sharing, and comparability across different studies and settings, ultimately leading to improved quality and reliability of HS models in healthcare.

Hybrid Models with Real-time Data: A Focus on Data Synchronisation and Experimentation

Professor Navonil Mustafee[1], Dr Alison Harper[1], Dr Joe Viana[2]
[1]University Of Exeter Business School, [2]BI Norwegian Business School

Parallel 9 - Hybrid Modelling and Simulation, Room 3.1, September 14, 2023, 11:00 - 12:30

Biography:

NAVONIL MUSTAFEE is Professor of Analytics and Operations Management at the University of Exeter Business School, UK. His research focuses on Modelling & Simulation (M&S) methodologies and Hybrid Modelling and their application in healthcare, supply chain management, circular economy and resilience and adaptation due to climate change. He is a Joint Editor-in-Chief of the Journal of Simulation (UK OR Society journal) and Vice-President of Publications at The Society of Modeling and Simulation International (SCS). His email address is n.mustafee@exeter.ac.uk.

Conventional simulation models used in Operations Research and Management Science (OR/MS) use historical data. With the increasing availability of real-time data, technologies commonly associated with applied computing, such as Data Acquisition Systems (DAS), may need to be integrated with conventional OR/MS models to develop Hybrid Models (HMs). We distinguish between HMs that use only real-time data – we refer to them as Digital Twins (DTs) – and those using a combination of historical and real-time data – called Real-time Simulation (RtS). Our previous contribution focused on the challenges of such integration, a concept referred to as information fusion, and presented a conceptualization of DT/RtS. This paper focuses on DT/RtS data synchronization and methods that could be employed from Parallel and Distributed Simulation (PADS). The conceptualizations and discussions reflect on the authors' experience implementing an RtS of a network of Emergency Departments and Urgent Care Centers in the UK.

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Open-Source Modelling for Discrete-event Simulation Re-use: a web-based application for Orthopaedic Elective Planning

Dr Alison Harper[1], Prof Thomas Monks, Prof Martin Pitt
[1]University of Exeter

Parallel 9 - Hybrid Modelling and Simulation, Room 3.1, September 14, 2023, 11:00 - 12:30

Biography:
Alison Harper is a Research Fellow at University of Exeter Medical School. She has an interest in applied health and social care modelling, hybrid modelling, real time simulation and model reuse in the healthcare sector.

Elective joint replacement surgery comprises one of the highest volumes of elective procedures worldwide. In the UK, orthopaedics has been the specialty under most pressure in terms of performance against National Health Service (NHS) elective operational standards. Prior to the COVID-19 pandemic, increased waiting times for elective orthopaedic surgery reflected limited NHS resources and the competing demands of rising emergency admissions. The effect of the pandemic on elective orthopaedic services has been to compound ongoing challenges, with larger waiting lists and a steep decline in performance. The increase in elective surgical waiting lists is creating significant challenges for health services and patients worldwide. Waiting lists are at record levels, with consequent deterioration in the health of patients who have had elective joint replacement surgery postponed.

In the NHS, the allocation of central capital funds to increase capacity for managing elective waits has created planning and operational challenges for health services. Health services are currently working to secure capital funds by delivering business cases that evidence optimal capacity and productivity configurations toward meeting new interim national targets. This paper reports on the development and deployment of an interactive web-based discrete-event simulation model for supporting capacity planning of surgical activity and ward stay in a proposed new ring-fenced orthopaedic facility in a UK health service.

The model was co-designed with a large health service in England, and is free and open-source. It has been developed to be generic and applicable for new capacity planning of elective recovery in orthopaedics in other regions. With minor adaptations it can also be readily modified for application to other specialties. It is currently in use in one health service, and has been handed over to several other NHS Trusts. Given the high current relevance of managing record elective waiting lists, there is potential widespread applicability of the simulation model which is supported by our open approach to modelling.

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Making an Impact

Human Centric Analytics (HCA): A workshop on how to foster the human centred development of analytics that augment human work effectively.

Dr Christina Phillips

Making an Impact - Human Centred Analytics, Room 3.16, September 13, 2023, 09:00 - 10:30

In situations of high uncertainty and high human involvement, it can be difficult to implement analytical tools, on the other hand those tools can serve to reduce and define the uncertainty. To achieve this level of use the human actors involved need to be empowered to understand and utilise the data that they produce and use. This requires both learning and experiment in a safe and creative space.
In this workshop we will use examples from industry interventions to introduce the ideas and concepts around HCA. We will discuss what works and what doesn't, and why that is, and develop skills around choosing the right structuring methods and analytical approaches for differing situations. Design is a key part of the process, and we will look at ways to keep in mind the iterative and empathetic journey that this helps to facilitate, while also looking at ways to integrate HCA into common working practices such as lean projects.
Please join us for what promises to be an interesting and informative session.

Grand Challenges and OR

Dr Miles Weaver[1]
[1]Edinburgh Napier University

Making an Impact - Grand Challenges of Bath, Room 3.5, September 13, 2023, 09:00 - 10:30

Biography:

Miles is an Associate Professor at Edinburgh Napier University Business School. His work focuses on bringing together systems thinking for sustainability. Particularly, to advance the acceleration of progressing the Sustainable Development Goals in place-based cross sector collaborations.

ORS Strategy - Your chance to input

Prof Martin Parr[1]
[1]Guided Systems Solutions

Making an Impact - ORS Strategy - Your chance to input, Room 3.9, September 13, 2023, 09:00 - 10:30

Biography:

Martin Parr is the founder and owner of Guided Systems Solutions and has worked for 20 years as a consultant on complex projects, many of which have been delivered for the public sector. Martin has delivered consultancy work to organisations including the Cabinet Office, Department for Education, Ministry of Defence, The Defence and Security Accelerator. Martin has advised on the governance of UK government programmes that have annual budgets in excess of £1 billion, including the Ministry of Defence test and evaluation programme. Martin's research interests include governance, assurance and the use of soft analysis in complex organisations. Martin has led masterclasses on Systems Thinking for the Department of Education, and has applied a wide range of systems approaches as Co Chair of a NATO international research group considering 'The Cost Related Implications of Autonomy.' Martin has taught Systems Thinking and Evidence Based Decision Making at the Defence Academy, Shrivenham and to a number of cohorts of PhD students at the University of Lancaster. Martin is a Chartered Engineer, a Fellow of the Institution of Engineering and Technology and a Fellow of the Operational Research Society.

https://www.linkedin.com/in/professor-martin-parr-a58a3620

Exploring Operations Research with R

Prof Jim Duggan[1]
[1]University Of Galway

Making an Impact - Exploring Operations Research with R, Room 3.15, September 13, 2023, 09:00 - 10:30

Biography:

Prof. Jim Duggan research focus is the area of applying system dynamics and data science methods to public health. His public health work includes using system dynamics to support pandemic preparedness and response, modelling scenarios of infectious disease outbreaks, and applying agile software design methods to develop a safety planning mobile app to address suicidality in young people attending community mental health services in Ireland. Prof. Duggan is a Managing Editor for the System Dynamics Review, and a member of World Health Organisation's Global Outbreak and Response Network (GOARN).

Twitter handle @_jimduggan

The aim of this workshop is to show how the R Programming language can be a valuable tool – and way of thinking – that can be successfully applied to the field of operations research. This idea is centred on an idea of the future operations research professional as someone who can combine key understandings from an array of OR techniques (e.g. simulation, linear programming, and data science) with a core knowledge of what R can provide in terms of data representation, manipulation and analysis, in order to develop actionable insights for decision makers.

Participants should create an account on posit cloud. https://posit.cloud and also have a laptop. Internet access required.

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OR65
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Radical Inclusion! Unlocking regenerative potential and systemic transformation from the inside out

Dr Louie Gardiner[1]
[1]University of Hull

Making an Impact - Radical Inclusion, Room 4.5, September 13, 2023, 09:00 - 10:30

Biography:

Dr Louie Gardiner, PhD, MBA, BA (hons), FRSA,

Author, Poet, Accredited Supervisor and Master Coach, Practitioner-Researcher, Change Consultant, facilitator/trainer, learning partner:

Louie has been passionately involved in liberating human potential for 30+ years. Her pioneering approaches are born of an enduring commitment to act for the wellbeing of all and to safeguard her own trustworthiness in whatever she does. Her deeply grounded practical knowing - manifesting in her composite doctoral submission - represents the evolving communion of real-world, personal and systemic practice and academic research over several decades.

Presence in Action and Symmathesic Agency are at the heart what she offers. This metalogically coherent body of work – underpinned by principles of natural inclusion, complexity thinking and primal animation – brings together radically different approaches to catalysing and nurturing personal, collective and systemic capacities for regenerative change – consciously, creatively, playfully.

She has contributed articles to both academic and practice-based journals e.g. Human Arenas, Cybernetics and Human Knowing, e-O&P Journal, Coaching Today, the3rdi magazine, and Book Chapters in Coaching Supervision Groups: Resourcing Practitioners (2021); Coaching Supervision: Advancing Practice, Changing Landscapes (2019); and The Collaboratory (2015). A signed copy of her poetry book Attending, Responding, Becoming: An anthology of surprises beyond intention or design (2021) is £30 available direct from Louie's website.

Louie's past roles include CEO, Board Trustee, Head of Corporate Performance & Development; visiting lecturer to undergraduate and post-graduate degrees.

twitter @Potent6 ; instagram potent6 ; linkedin https://uk.linkedin.com/in/louiegardiner

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Traditional science paradigms dominate the academy and emphasise – if not expect – third person accounts, effectively marginalising the validity of personal knowing. Some systems thinking, cybernetics, systemic interventions and complexity approaches recognise the flaws in obviating the subjective-empirical dimension, yet virtually none offer simple, practical ways to fully leverage its inclusion amidst daily life, work and research – wherever we are, whatever we are doing.

In my doctoral research, I took on an ambitious challenge to (a) explore what it might mean in theory, and deliver in practice, to re-incorporate personal knowing alongside second and third person sources; and (b) to do so, by embracing and embodying the complexity I was experiencing in and as a 'complex living system'. This called on me to surrender to 'not knowing' and to let this be my guide.

In this participatory workshop – if you are willing to engage in the unexpected – I will offer you an experience that will illuminate the re-generative potential of radical self-inclusion and demonstrate its necessity in catalysing personal and mutual contextual learning/transformation. I will give you a taste of this through a multi-modal, 'metalogically coherent' approach.

But do be aware – what you experience may disrupt your beliefs and expectations of what it means to work systemically. Indeed, you may find yourselves questioning the very foundations of your favoured ways of undertaking systemic work!

Depending on what beckons for our attention in the session, we may touch upon any or some of the following novel contributions arising from my research:

- Systemic Research Framework
- Presence in Action
- Symmathesic Agency
- Metalogic coherence
- Re-formulation of abduction

Those signing up to this workshop will be given access to additional links that will elaborate on all these concepts and associated frameworks.

Keywords
Abduction, complexity, metalogic coherence, Presence in Action, subjective-empirical, symmathesic agency, systemic intervention; systemic research framework.

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Systemic Leadership in Healthcare:

Transforming the Employee Experience While Delivering Extraordinary Patient Value

Mr. Daniel Edds[1]
[1]Praxis Solutions

Making an Impact - Systemic Leadership in Healthcare, Room 4.1, September 13, 2023, 09:00 - 10:30

Biography:

Daniel B Edds, MBA has been a practicing management consultant for more than twenty-five years. His clients include healthcare, state and local government, higher education, K-12 education, and nonprofits. He is the author of, Leveraging the Genetics of Leadership, cracking the code of sustainable team performance. This is the first book that documents through case studies and interviews with key leaders in healthcare, manufacturing, education, small business, and the U.S. Military on how to build high-impact organizations with systems design and thinking. Beginning with a systemic approach to leadership, these unique organizations are generating value greater than their size would indicate is possible. By removing personality from leadership and replacing it with an integrated leadership system, organizations of any size can transform their workplace and deliver unparalleled customer value.

https://www.linkedin.com/in/danieledds/

High-impact organizations have two primary characteristics, 1) they create a transformative work experience for employees, and 2) they consistently deliver extraordinary value to their customers. These organizations have the distinction of transforming the lives of their employees, contributing directly to their self-confidence, and sense of personal significance. In addition, they deliver an experience to their customers for which they can charge premium prices.

Healthcare in the U.S. consumes 17% of GDP, or nearly $3 Trillion USD annually. It is estimated that a third of this is waste. In addition, avoidable accidents and missed diagnosis account for 166,000 deaths each year. This makes healthcare the third leading cause of death in America. High-impact healthcare organizations reverse these trends through the intentional design of a leadership system. In short, they build a system of leadership and then train, coach, and mentor every leader and manager to its requirements.

There is a plethora of management frameworks, each promising to comprehensively improve clinical outcomes while eliminating waste. They include The Toyota Production System (Lean), the Balanced Scorecard, the National Baldrige Quality Criteria, as well as industry-specific best practices. However, researchers and theorists in the field of organizational performance are recognizing the reality – they do not work with traditional models of leadership. For example, Mary Uhl-Bien, in her seminal paper titled " Complexity leadership theory: shifting leadership from the industrial age to the knowledge era," recognizes that traditional models of leadership are no longer working in a complex and knowledge-driven economy, such as healthcare.

This workshop will review how two healthcare organizations are reversing these trends. Both are using different frameworks, but both have also developed integrated and systemic approaches to their leadership. One is a small rural healthcare organization that is holistically improving the health of its entire community. The second is a large urban healthcare organization that is regularly recognized as the safest hospital in America.

This workshop will provide a systemic model of leadership that has proved to build high-impact organizations that transform the workplace and deliver extraordinary customer value.

Running on empty!

Dr Louis Arnoux[1]
[1]Fourth Transition Initiative

Making an Impact - Running on empty, Room 4.8, September 13, 2023, 10:50 - 12:20

Biography:
Louis has worked for over 54 years at the interface between governments, business, engineering, science & people. He has assessed and evaluated 1000s of technologies, policies, strategies plans; took part in a number of technology, products, services and industrial developments; advised numerous businesses, regional, governmental and supranational bodies in a number of islands and continents.

Over those years, he mostly self-funded his research through consulting and contract work. The Fourth Transition Initiative now benefits from this large body of prior R&D. He has recently established that the globalised industrial world (GIW) is rapidly losing its thermodynamic foundations and that none of the by now mounting global threats, including global warming, can be addressed without first building new sustainable thermodynamic foundations. To do so, there is an urgent necessity to access a new, large energy pool, the solar influx, in sustainable and affordable ways. The current technology mix can't deliver, so-called "renewables" included. There is a sheer necessity to accomplish a Fourth Transition (after Hunting and Gathering, Agriculture and Urbanisation, and Industrial Revolution) integrating key changes in ways of accessing and using energy, modes of social organisation as well as modes of thinking and decision-making. In response to this situation, together with a number of colleagues he is presently developing the nGeni Technology Class and Technological System, along with associated business and financial models as catalysts to enable triggering such a Fourth Transition.

Recent systems dynamic research by three researchers working independently from each other demonstrates that the globalised industrial world (GIW) is now a whisker away from Dead State – that is, when the total energy cost of getting energy comes to equate with the total gross energy extracted and everything grinds to a halt, i.e., concerning energy from all sources and the whole of the global energy supply and use system (GESUS). The critical time horizon is around 2030, understood as an inflection marker year, not a hard end point. End of GESUS means the end of the GIW, aka abrupt collapse, in the near future. However, preposterous this may seem, the thermodynamic data is massive and inescapable. It is definitely not worth taking the risk of ignoring or denying this threat, as so many decision-makers have done for decades concerning what has become the Climate Emergency. Our data shows, that “decarbonising with renewables and/or nuclear, and EVs” cannot in any way address the Dead State threat. In fact, it can only make matters far worse, building a

second thermodynamic trap within the Dead State trap. In short, the Dead State threat is one of the most significant systemic challenges facing contemporary society. It is inherently a non-linear dynamic, in the sense that the impacts will be sudden and dramatic, rather than incrementally creeping up on us. Understanding its systemic character and designing systemic responses are essential if we are to avoid complete societal collapse. To date, people have remained blind to the emerging threat essentially because they did not look. They did not look because their entire political and/or business culture led them to focus on other (much lesser) matters, and also because the thermodynamics and systemics of the GIW and of the GESUS constitute a very difficult domain to research that few people are familiar with. The proposed workshop will include a 20-minute concise presentation of our findings followed with a 70-minute discussion among participants of those findings, implications, and systemic ways of developing strategies to address the challenges ahead in the near future.

Large-scale Brain Networks and Complex Problem Solving - Application in Practice using Metaphor and Guided Relaxation

Mr Mike Parker[1]
[1]Liminal Coaching Limited

Making an Impact - Large Scale Brain Networks and System Thinking, Room 4.8, September 13, 2023, 09:00 - 10:30

Biography:
the Founder of Liminal Coaching and developed the technique that gave the company its name.

He has over 30 years of experience helping clients innovate, overcome challenges, and improve performance across a wide range of personal and professional domains.

Mike's interests are deep and broad, ranging across psychology, anthropology, philosophy, math, business, music, economics, culture, and systems thinking. He has an MBA in innovation, finance and strategy and has supplemented this with further postgraduate studies in Systems Thinking and Governance.

He is a qualified Solutions Focused Therapist and a Research Fellow at the Schumacher Institute, an independent think tank dedicated to solving complex social, economic and environmental crises.

This interactive session will review recent research showing the significance of brain states where the Default Mode Network is activated for the creative generation of solutions to complex problems. This is followed by a practical session designed apply this hypothesis in practice.

"The default mode network (sometimes simply called the default network) refers to an interconnected group of brain structures that are hypothesized to be part of a functional system. The default network is a relatively recent concept, and because of this there is not a complete consensus on which brain regions should be included in a definition of it. Regardless, structures that are generally considered part of the default mode network include the medial prefrontal cortex, posterior cingulate cortex, and the inferior parietal lobule" Marc Dingman Ph.D.

I will cover a variety of claims being made about the function of the DMN, showing that this is still a rapidly developing area of research.

However, the linking of the DMN and other large-scale brain networks to creativity in recent research ties in with psychological studies on mind wandering (daydreaming) and creative solution development.

The second half of the session will be a guided relaxation session using metaphoric scenarios constructed to activate and focus the DMN and other networks involved in creative insight. In the past year, this session has been successfully used with the exec team of a large New York PR company prior to their annual strategy day workshops and a large UK government agency to kick off its exploration of the application of Systems Thinking to solving complex problems.

There should be time for Q&A at the end.

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The relational body - considering bodies' relational and expressive possibilities in systemic work

Mr Mark Huhnen[1]
[1]Systemark ltd

Making an Impact - The Relational Body, Room 4.10, September 13, 2023, 10:50 - 12:20

Biography:
Mark studied social pedagogy in his native Germany before coming to London (via Spain) to study physical theatre. While working in social and community context as well as performing he studied to become a systemic psychotherapist and coach. He has just had his viva for a Professional Doctorate in Systemic Psychotherapy and is now Workington some corrections. The title of the thesis was "How to do things without words", challenging the focus on words in systemic practices following what has been termed the linguistic turn and the embracing or social constructionism.

During my doctoral research I found a leaning towards the spoken and written word in systemic practice, particularly after what has been called the linguistic turn and the embracing of social constructionism. I theorised in what way this might be problematic. What might we miss when we attend less to non-verbal, physical or dynamic (as opposed to symbolic) expressions and actions when working with human systems (for example in Family therapy of coaching). I developed techniques that can be used by practitioners who work with human systems.
In this workshop I will offer some of these techniques for participants to experience and we will have an opportunity to discuss some of my research findings. We might get to develop some more techniques.

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Managing stakeholders in analytical projects

Mr Ian Seath[1]
[1]Improvement Skills Consulting Ltd.

Making an Impact - Stakeholder Management, Room 3.16, September 13, 2023, 10:50 - 12:20

Biography:

Ian is an independent consultant and Director of Improvement Skills Consulting Ltd. He works with clients in the private, public, and voluntary sectors and specialises in process improvement, project management and performance management. With an honours degree in Chemistry and a postgraduate HR diploma, Ian's early career was in the manufacturing sector (paper industry). He worked in R&D, Marketing, HR and Commercial roles prior to joining a niche continuous improvement consultancy.

In the OR Society, Ian was a steering group member of the Criminal Justice SIG and is currently a member of the Pro Bono OR Steering Group. He regularly provides pro bono support to third sector organisations and is also a trustee of Dachshund Health UK, a registered charity.

@ianjseath on Twitter

Stakeholder management is the process of identifying, assessing, and managing the expectations of all individuals and groups who could affect or be affected by a project, decision, or policy. It is an essential skill for any OR professional who wants to be successful in their career. More projects fail for lack of stakeholder engagement, in the right way, at the right time, than from ineffective use of tools and techniques.

This highly participative workshop will provide you with the knowledge and skills you need to effectively manage stakeholders. You will learn how to:

* Identify all of the stakeholders involved in a project
* Assess the needs and interests of each stakeholder
* Develop communication strategies appropriate to different stakeholders

By attending this workshop, you will be able to:

* Improve your chances of success in managing projects
* Build stronger relationships with stakeholders

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Going Real Time - Simulation Driven Digital Twins

Christoph Werner

Making an Impact - Going Real-Time Simulation Driven Twins, Room 3.15, September 13, 2023, 10:50 - 12:20

A simulation is not a digital twin (no matter what some people claim!) but a digital twin without simulation is pretty meaningless. What's the point in knowing the exact current state of your process if you can't get some insight about what's coming next and what you could do to improve performance over the next few weeks, or months?

A simulation drive digital twin is a continuous use simulation with a regularly refreshed data feed. This creates your new secret weapon to deliver business agility and resilience. A simulation driven digital twin sits at the table with your operational management team proving them with foresight to mean that fire fighting is a thing of the past.

In this workshop we'll show you

- Some examples of the simulation driven digital twins we've built and discuss the use cases of operational decision making where they make the biggest impact
- We'll share some of our lessons learned from building these types of simulation
- Then we'll show you how to do it yourself
  - How you embed Simul8 inside your operational technology stack to leverage real time data feeds for inputs
  - How to create and link to external tools such as the likes of PowerBI to process owners with process insights inside their current operational management tools
  - How you leverage COM to control any aspect of Simul8 from any application such python, R, excel whatever
- You'll also get a sneak peak at our R&D activities in this exciting new area where we'd love to collaborate with you

Come join us to see the future of simulation in action.

OR@75 –75 Years of Operational Research (OR) Practice

Mr John Medhurst[1], Dr John Ranyard, Dr Roger Forder, Mr Alan Robinson
[1]Larrainzar Consulting Solutions Ltd
Making an Impact - 75 Years of OR in Practice, Room 4.1, September 13, 2023, 10:50 - 12:20

Biography:
John Medhurst has worked in OR for 38 years and is currently Chair of the OR Society Events Committee and the OR Society Board lead on the 75th Anniversary celebrations.

The OR Society is 75 this year and as part of the celebrations of this anniversary we will be looking back at 75 years of OR Practice, starting with how OR expanded from its military origins in World War II to becoming a vital tool for the management of peacetime industry. The review will look at the growth of OR during the 1950s and 1960s, the emergence of systems approaches in OR practice in the 1970s and will examine how OR has changed and developed through the ages of the mainframe, the personal computer and on into the world of the internet, big data and AI.

The session will include some short presentations on the history of OR practice both from the perspective of a former long-term secretary of the Heads of OR and Analytics Forum (HORAF) and President of the OR Society, a former Chief Analyst of the Defence Science and Technology Laboratory (Dstl) and the current Head of Profession for OR in the Ministry of Defence (MOD).

These will serve to set the scene for a discussion session which will allow us to gain some insight into how OR Practice has changed over the 75 Years of the Society's existence, what the technological and social factors driving that evolution have been and what some of the constants might be.

This will allow those attending to understand more about how this history of evolution and development might hold lessons for the next 75 years of OR Practice.

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A Model of Systemic Leadership. Designing the Leadership DNA of High-Impact Organizations

Mr. Daniel Edds[1]
[1]Praxis Solutions

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Daniel B Edds, MBA is the author of, Leveraging the Genetics of Leadership, cracking the code of sustainable team performance. This is the first book that documents through case studies and interviews with key leaders in healthcare, manufacturing, education, small business, and the U.S. Military on how to build high-impact organizations with systems design and thinking. Beginning with a systemic approach to leadership, these unique organizations are generating value greater than their size would indicate is possible. By removing personality from leadership and replacing it with an integrated leadership system, organizations of any size can transform their workplace and deliver unparalleled customer value.

There is a growing body of evidence that traditional models of leadership are not working. As organizational complexity increases, the expectations and demands on individual leaders must also increase until they must attain superhuman status (Kollenscher, et al., 2016).

Jim Clifton, Chairman of the Gallup organization, and writing to a U.S. audience states:

“The American leadership philosophy simply doesn’t work anymore” (Gallup, 2017).

However, poor organizational performance such as low employee engagement, low customer satisfaction, and poor financial returns is often not the result of bad leadership. It is the result of poor leadership systems. As Deming stated,

“Every system is perfectly designed to get the results it gets.”

Therefore, improving the system (of leadership) will improve organizational performance for all stakeholders.

Leveraging the Genetics of Leadership, cracking the code of sustainable team performance is the first book of its kind that documents through empirical research how high-impact

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organizations approach the practice of leadership systemically. By designing a leadership system, they can train, coach, and mentor every leader to execute the requirements of the system. The result is higher employee engagement, higher customer satisfaction and retention, and higher performance for all stakeholders.

This poster will visually display this systemic model of leadership and identify the organizations profiled as case studies in the book. These case studies include organizations in healthcare, manufacturing, education, small business, and the U.S. Army.

Have fun and give back - volunteer with The OR Society

Mrs Eve Hardy[1]
[1]The OR Society

Making an Impact - Have Fun and Give Back – ORS Volunteering, Room 3.9, September 13, 2023, 10:50 - 12:20

Biography:
Fay and Eve manage the Education and Pro Bono outreach programmes at The OR Society

Volunteering with The OR Society can take several forms and bring you several benefits. Join Fay and Eve to learn how and why you should get involved, from attending science fairs to supporting charities, shaping The OR Society to telling people how we can help them, there's lots of ways to get involved. Volunteering with us is a fun way to build your professional network, learn new skills and give something back to your community.

Twitter handles: 'at'ProBonoOR 'at'ORinEducation

Educating governance architects to design self-governing organizations

Dr Shann Turnbull[1], Senior Scientist Yiannis Laouris[2]
[1]International Institute for Self-governance, [2]Future Worlds Center - Cyprus Neuroscience & Technology Institute

Making an Impact - Self-Governing Organisations, Room 4.5, September 13, 2023, 10:50 - 12:20

Biography:
Shann Turnbull graduated as an electrical engineer in Tasmanian and with a Batchelor of Science in physics and mathematics at the University of Melbourne. After completing a Harvard MBA, he became a serial entrepreneur establishing a flying school, a film finance business, two public mutual funds, and three other enterprises that became publicly traded. He was a co-founding member of a private equity group that in its first four years acquired control of fourteen publicly traded firms. He co-founded the first educational qualification for company directors in the world in 1975 and wrote Democratising the Wealth of Nations launched by the Deputy Prime Minister of Australia. As a result of his book, he was invited to Prague in 1990 & 1991 and to Beijing in 1991 to advise on stakeholder privatization. His Ph.D. research introduced bytes as the unit of analysis to establish the science of governance to investigate self-regulation and self-governance of any specie. Transaction Byte Analysis explains why biota uses a requisite variety of distributed decision-making to simplify complexity. Also, to create tensegrity required to achieve self-regulation and self-governance but capable of adaption and evolution. Google reveals he is a prolific author on reforming the practices of capitalism based on biomimicry.

https://www.linkedin.com/in/shannturnbull

https://twitter.com/shannturnbull *https://www.facebook.com/Shann.Turnbull*

The objective of this workshop is for participants to learn how to fill a global knowledge gap. This is how to educate governance architects to custom design corporate constitutions for creating self-governing organizations. Polycentric self-governing organizations become crucial agents, to simplify, and comprehensively, control the complexity of risks facing humanity. Participants will be provided with a briefing note of the types of features required for an organization to become self-governing without markets or state. They will then form syndicates of two or three people. Each syndicate would then develop a grading system to evaluate the ability of organizations to become self-governing and apply their grading to three self-selected examples. They would be a firm, non-profit organization, and a public

sector organization from any level of government. Syndicates could include new criteria and decide the weighting for each criterion. The results from each syndicate would then be presented on a screen for evaluation and discussion by other syndicates. Each syndicate could then refine its grading system. Each syndicate would select one example to redesign its corporate constitution to improve its grading. The results would also be shared for each syndicate to evaluate, discuss, refine, and/or defend to improve its ability to become self-regulating and self-governing. Attendees of the workshop could then pitch their solution, to their case study, to engage them to implement it or a fee. Also, to organize similar workshops to teach the teachers. They could also suggest ways to improve the pedagogy utilized in the workshop which is based on an approach developed by one university as a 40-hour elective MBA unit 20 years ago. It was delivered in five working days over two weekends separated by a weekend or two to allow detailed research of their selected solitary case study.

Creativity Workshop - Yes, you too can be creative!

Dennis Sherwood[1]
[1]The Silver Bullet Machine Manufacturing Company Limited

Making an Impact - Creativity Workshop, Room 3.15, September 13, 2023, 16:00 - 17:30

Biography:
Dennis is one of the country's leading experts on creativity and innovation, especially as regards bridging across to OR. Formerly a consulting partner at Deloitte Haskins + Sells (a predecessor of PwC) and an Executive Director at Goldman Sachs, Dennis now runs his own business, Silver Bullet. Dennis has written many articles and blogs, and is the co-author of 3 books, and sole author of 12 others, including "Creativity for Scientists and Engineers", published by the Institute of Physics, and winner of the "Specialist Business Book" category of the 2023 UK Business Book Awards.

Website www.silverbulletmachine.com; twitter, @noookophile; amazon page, https://www.amazon.co.uk/Dennis-Sherwood/e/B001HPMK0K?ref=dbs_a_def_rwt_hsch_vu00_tkin_p1_i0

How does creativity actually happen?

What, fundamentally, is creativity anyway?

Can you have great ideas ‘on demand’?

Do you have to be a ‘design thinker’?

Or can an ‘ordinary’ person be creative?

These are important questions, and answering them is what this session is all about…

This highly interactive workshop will be led by Dennis Sherwood, an expert in creativity, modelling and systems thinking, and author of the award-winning book, "Creativity for Scientists and Engineers".

Exploring a shared orientation across the landscape of systems thinking and acting

Mr Gary Smith[1]
[1]Airbus

Making an Impact - Systems Thinking and Acting, Room 4.10, September 13, 2023, 16:00 - 17:30

Biography:
Gary is an INternational Council On Systems Engineering Expert Systems Engineering Professional and senior expert in systems engineering at Airbus Defence and Space. He is a lead architect for system of systems solutions and is currently working on transformation programmes.

He is an active contributor to the INCOSE systems science and healthcare working groups where he participates as the outreach leader for the EMEA region and is an INCOSE Healthcare Ambassador.

He is the VP for System Practice at the International Society for System Science and is the relationship manager with INCOSE as well as the senior editor for section 2 of the SEBOK – Foundation for Systems Engineering.

Currently in the context of system science he is leading an effort towards an integrative framework for system knowledge, connecting explicit connections between theory and practice.

The complexity and complicatedness of our world is escaping our ability to comprehend, work, interact, and live successfully within it. The buffers of time and space that our planet provides have been depleted such that we are now truly experiencing the emergent effects in global crises. As a result, there is a growing need to focus not just on the symptoms we perceive in any situation, but on underlying patterns and structures; to understand the mental models that drive these and thereby take action to mitigate the dangers from unintended consequences. These are however wickedly complex problems and this level of complexity requires and demands greater appreciation. This ever pressing need has driven invention and many diverse Systemic frameworks have evolved heuristically to help people make sense of such complex problems. Our collective frameworks are, however, disordered and have led to unnecessary competition, unproductive tension, challenges in communication and confusion in practice. As we well know - “A disordered whole is practically less than the sum of its parts” - Alexander Bogdanov ~1917.

INCOSE, in collaboration with ISSS, has been working to create a holistic framework for Systems Science. Its purpose is to provide the means to organise the pursuit and practice of systems knowledge as a learning system.
Here we continue the exploration of a candidate integrative or meta-framework for system knowledge, one where our diverse frameworks, theories, methodologies and practices might no longer be disconnected and part of a greater whole. A framework that could provide a shared orientation to empower our research and practice. With the capability to tightly connect and integrate all systems knowledge, the concepts, theories, practices and assets become understood in the context of the system pathologies, anti-systemic pathways and problems that we face. The powers necessary for the resolution of these problems become apparent and the positive pathways we can pursue to realize opportunities for systemic transformational change are revealed.

Systems Thinking for Strategic and Operational Improvement

Dr Krishna Balthu[1], Prof Ben Clegg[1]
[1]Aston University

Making an Impact - Systems Thinking for Strategic and Operational Improvement, Room 4.5, September 13, 2023, 16:00 - 17:30

Biography:

Prof. Ben Clegg

Professor Ben Clegg is a professor of operations management and systems thinking at Aston Business School, Aston University, UK. Ben's research focuses on the application of systems thinking to operations improvement: strategic change, digitalization, leanness, quality improvement, efficiency, productivity and effectiveness in manufacturing and services. His teaching focuses on post graduate education to MBAs, businesses and short professional courses. His research has led REF impact cases in 2014 and 2021. Ben has published hundreds of research papers (conference and top journals), won more than £2m of research funding, been elected to the European Operations Management (EurOMA) committee, has organised international conferences, and has served on the IET fellowship panel. He has a leading textbook 'Operations Management' from McGraw-Hill (2e, 2021). He has also been Head of the Operations and Information Management Department and Associate Dean for Business and Community Engagement.

Dr Krishna Balthu

Dr Krishna Balthu is a Lecturer in Operations Management at Aston Business School. He worked as a consultant and change manager in knowledge-intensive organisations for over ten years prior to teaching at Aston. Using action research, he delivered an award-winning research project funded by Innovate UK. Krishna's research is focused on how systems thinking can be applied to achieve sustainable and effective change in organisations. Krishna's work was published in top-ranked journals such as International Journal of Operations and Production Management among others. His work in the field of legal service innovation was recognised through awards, published magazine articles, and invited talks at various forums such as Innovate UK, The Lawyer, ILTA and European Foundation for Management Development. Krishna is committed to advancing the field of systems thinking through his research and teaching, and he is passionate about sharing his insights with others in the field.

Soft Systems Methodology (SSM) is a contrasting approach to so-called 'hard systems methodologies'. SSM can improve human activity system problems that are complex in nature and difficult to optimise (Checkland, 1981).

In this workshop we explore how a novel Soft Systems Methodology called Process Oriented Holonic (PrOH) Modelling has been used to investigate and improve complex organizational problems, such as those found in strategic operations management, within both manufacturing and service organisations (Clegg, 2007; Balthu & Clegg, 2021). Built on the principles of Checkland's SSM PrOH Modelling in Action Research contexts engages with the problem situation / system under observation and delivers practical changes. PrOH modelling is for strategic operations management improvements but can also provide new insights to systemic thinking.

Using examples from both manufacturing and service organisations, this workshop will explain how PrOH Modelling facilitated the change journeys of organisations which used this novel approach. Discussion will combine research rigour and industrial relevance based on high-quality journal publications and REF impact case studies.

Using a gamified approach, this workshop will allow delegates to learn the principles of PrOH Modelling Methodology in an innovative and engaging manner. This workshop will appeal to researchers who would like to develop their process modelling, change management and action research skills. It will also appeal to practitioners/consultants who would like to lead impactful transformational change programmes in their organisations as PrOH Modelling can be used as a systemic Problem Structuring Method (PSM) to broaden perspectives of participants and facilitate discovery of emergent (and hidden) systemic strategies and actions (Midgeley et al., 2013).

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Sherlock's Dilemma -- Systems Thinking or ChatGPT?

Dr Wenxian Hetty Sun[1], Mr Aaron Tan[1], Miss Daria Samatoina[1]
[1]Greenwich Business School

Making an Impact - Sherlock's Dilemma, Room 4.8, September 13, 2023, 16:00 - 17:30

Biography:
Dr. Hetty Wenxian Sun is an Associate Professor, Senior Fellow of HEA, and CMBE who is recognised as a systems thinking practitioner. In addition to her specialisation in project management, she applies systems methodologies to effectively address complex issues within projects. Her expertise in systems thinking extends beyond projects, as she actively fosters responsible leadership among small and medium enterprises (SMEs) and plays a key role in developing local entrepreneurial ecosystems.

As the Associate Head of Research and Knowledge Exchange within the Executive Business Centre of the Business School, Hetty leverages her systems thinking expertise to enhance her own managerial practice. By adopting a holistic approach, she promotes a comprehensive understanding of the interconnections and interdependencies within the organisational context. This enables her to navigate challenges and make informed decisions that consider the broader implications and consequences.

Abstract:
This action-based workshop is designed to engage participants in an immersive and interactive experience, fostering the 'visualisation' of the application of or the underlying attempt of adopting systems methodologies and methods in practice. The 90-minute workshop revolves around assisting the renowned detective Sherlock Holmes in solving a captivating 'case', encouraging a self-reflexive stance that fully appreciates individual, mutual, and collaborative strengths.

The workshop draws upon the principles of systems thinking, with a particular emphasis on Critical Systems Thinking, to enable participants to gain a comprehensive understanding of the concepts and tools associated with systems thinking.

As the workshop aligns with the current trend of AI exploitation, especially in the realm of language models like ChatGPT, it also provides a platform for an open dialogue on systems thinking within the AI era. Participants will have the opportunity to reflect on the implications of systems thinking in relation to AI technologies and explore the potential synergies and challenges that arise from the interplay between systems thinking and AI.

The workshop aims to facilitate meaningful discussions, knowledge sharing, and experiential learning, enabling participants to develop a deep appreciation for the value and relevance of systems thinking in contemporary problem-solving landscapes. Attendees will emerge with enhanced problem-solving skills, a broader understanding of systems methodologies, and insights into the critical intersection of systems thinking and AI.

Keywords: systems thinking, Critical Systems Thinking, problem-solving, collaborative strengths, systems methodologies, AI exploitation, ChatGPT.

L7 Systems Thinking Practitioner Apprenticeship Workshop

Miss Helen Sanson[1], Mr Dan Amin
[1]Forcera + Advance HE

Making an Impact - L7 System Thinking Apprenticeship, Room 4.1, September 13, 2023, 16:00 - 17:30

Biography:

Dan Amin is the Quality and End-point Assessment Manager for Advance HE, the first recognised End-Point Assessment Organisation for the L7 Systems Thinking Practitioner Apprenticeship. Helen is the Director of Forcera and one of three consultants that worked with Dan to create the handbook for the apprenticeship.

Helen and Dan will give an overview of the L7 Systems Thinking Practitioner Apprenticeship. There will be a chance to meet some of the providers who will explain their perspectives about the apprenticeship and have a go at some systems thinking activities.

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OR and Net Zero

Multi-criteria Decision Making for Site Selection of Freight Macro Consolidation Centres in the Solent Region

Dr Mohanad Al-behadili[1], Mr Andrew Bullock[1], Dr Reza Eshtehadi[1], Djamila Ouelhadj[1], Dr Graham Wall[1]
[1]University Of Portsmouth

Parallel 3 - OR and Net Zero, Room 4.1, September 12, 2023, 14:45 - 15:45

Biography:
Dr Mohanad Al-behadili, Senior Research Associate at the University of Portsmouth. Lead the projrct of Macro Consolidation for Freight Logistics in the Solent region. Has a PhD in OR from the University of Porsmouth in 2017.

The growing urbanisation in the UK is causing a rise in urban freight volumes. This in turn increases negative impacts on the area such as pollution, congestion, etc. In addition, there is usually a shortage of urban space in cities including in the Solent region and its cities such as Portsmouth (the focus of this project and paper). A Macro Consolidation Centre (MCC) is one method to mitigate this problem by consolidating freight flows between different suppliers and the last mile hubs or customers.

Transport is the largest contributor of emissions, with total carbon emissions of 24% produced in the UK and 22% in Portsmouth in 2020. Freight transportation contributes a large proportion of air pollution, which has negative environmental and social impacts. By consolidating the multiple shipments into a single shipment, an MCC can reduce the number of delivery vehicles and reduce the vehicle mileage with less fuel use, therefore reducing the impact of vehicle emissions.

The MCC project addressed in this paper is part of the Solent Future Transport Zone project (FTZ) funded by the UK's Department for Transport and led by Solent Transport.

The problem of finding the best location for MCC is a multi-criteria decision-making problem, which involves a set of decision criteria. This paper considers developing a multi-criteria-decision support framework using an Analytic Hierarchy Process (AHP) to find a suitable site for MCC to serve the city of Portsmouth, then extending the methodology for the Solent region. The criteria proposed in this paper includes the sustainability criteria: Economic, Social and Environmental with sub-criteria that are identified and categorised

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within the main criteria. The locations considered for MCC are selected based on real GIS and geographic data from Portsmouth. The proposed multi-criteria selection framework comprises the following four steps: Development of hierarchical structure for the AHP, identification of the weights, data collection and finally, selection of the suitable location of a MCC. The proposed approach is evaluated with a case study of an MCC in Portsmouth. The results demonstrate that the proposed multi-criteria framework is capable of finding the best location for the MCC in Portsmouth.

On optimized pricing of shared cars

Dr. Rym M`hallah[1], Professor Christine Currie
[1]King's College London

Parallel 3 - OR and Net Zero, Room 4.1, September 12, 2023, 14:45 - 15:45

Biography:
Prof Rym M'Hallah (92'PhD in Industrial Engineering and Operations Research, Pennsylvania State University, USA) is expert in optimizing large-scale systems. In 2021, she moved to the UK, to hold a Chair position on Systems Engineering at the Faculty of Natural, Mathematical and Engineering Sciences at King's College London. She is an editorial board member of the European Journal of Operational Research, RAIRO-Operations Research, and Operations Research in Health Care. She managed teams of research engineers who designed, developed, and deployed information, optimization, and decision support systems for management, production, maintenance, and planning. Applications include transport, manufacturing, and health care. Her research is funded by UKRI.

Car clubs and shared cars could pave the way to a transition toward net zero by reducing the use of private cars. The transition requires them to be financially sustainable to service providers and attractive to end users. This translates into optimizing prices for car hire as a function of demand and supply, i.e., dynamic pricing can incentivize users while balancing supply and demand at different pickup locations.
We employ Markov chain models and computer simulation to determine optimal dynamic pricing strategies for a car club with a fixed fleet size. The Markov chain model describes the system and gives analytical expressions for the optimal price to charge for different system parameters of the car share problem and the corresponding service level, expressed in terms of car availability. It further enables us to prove that, under general conditions, the expected revenue is concave, and the optimal prices are unique regardless of the willingness-to-pay distribution.
The computer simulation enables us to include more complexities of the system into the model and to assess its performance. We use simulation optimization techniques to find the optimal pricing strategy. Finally, we validate the analytical and simulated results, compare the expected revenue and service level for different pricing schemes, and present some recommended pricing strategies for a set of standard willingness-to-pay distributions.

Combing novel methods for the selection of representative days to fasten the optimization of the European electricity system under climate uncertainty

Leonie Sara Plaga[1], Prof. Dr. Valentin Bertsch[1]
[1]Ruhr-University Bochum

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Leonie Plaga studied physics at Technical University Dortmund. After completing her master's degree in 2020, she started a PhD at Ruhr-University Bochum, Chair of Energy Systems and Energy Economics in Mechanical Engineering. She works in the field of energy system optimization with a focus on the impact of climate change and its uncertainties on energy system optimization. She has published a review paper titled "Methods for assessing climate uncertainty in energy system models — A systematic literature review" as well as three conference contributions. Furthermore, she is engaged with teaching OR methods to students in the state funded project "OR4sustainability".

Anthropogenic climate change is expected to cause significant shifts in the Earth's climate in the coming years. Despite advances in climate modeling, there remains substantial uncertainty regarding future climate developments. Energy system models can be used to optimize the development of future energy systems and reduce greenhouse gas emissions. However, as multiple energy system elements depend on climate variables, climate change and its uncertainties impact the outcomes of these models. Energy systems strongly dependent on renewable energy sources are thereby particularly susceptible to changing climatic conditions.
This presentation focuses on optimizing a model of the European electricity system using the energy system optimization model backbone. The model considers only low carbon electricity sources (wind, solar, nuclear power) and storage systems to create a low carbon electricity system.
To incorporate uncertainties arising from climate change, outputs from multiple climate models with different Representative Concentration Pathways are used. Yet, the use of multiple climate models results in very large energy system models and thus in high computation time. Hence, this presentation focuses on timeseries aggregation methods that select representative periods from the full dataset. We combine two novel clustering methods and compare the results to established sampling methods like k-means clustering. The first method to be combined optimizes each day individually and clusters the days based on this results. The second method assigns importance to each day based on a predefined criterion, with more important days having a higher likelihood of becoming representative periods during the clustering process. In this study, investment decisions

from one-day optimizations are used for clustering while using total costs as the importance criterion.
The combination of these two methods reduces errors arising from the clustering process, particularly for system costs. For example, the average system cost deviation from the full data set results is reduced to 0.94% compared to 26.1% for k-means clustering. Additionally, the error for investment decisions decreases from 9.3% to 1.7%. In the future, these results shall be used in large models with multiple climate models and stochastic optimization techniques to provide guidance on planning robust energy systems that can withstand various climate developments.

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Optimisation under Uncertainty

Operating room allocation to indoctors and outdoctors under uncertain surgery durations

Dr Arsham Atashi Khoei[1], Dr Serhat Gül[2], Dr Melih Çelik[1]
[1]University of Bath, [2]TED University
Parallel 1 - Optimisation under Uncertainty, Room 3.15, September 12, 2023, 09:15 - 10:45

Biography:
Arsham was awarded his PhD degree from Middle East Technical University in Ankara. His academic background comes from Industrial Engineering and Operational Research, and his research interests mainly include optimization problems and algorithms in logistics. Since April 2022, he has been a Research Associate at the School of Management of University of Bath. He has been working with the "Dynamic Routing and Order Picking Efficiency for Smart Warehousing" project, and with the Centre for People-Led Digitalisation, with expertises on application of optimization algorithms for assessment and improvement of digitalisation and smartness in different divisions of industries such as manufacturing and logistics.

Planning of operating room (OR) use is an important decision in determining the efficiency of resource use in a hospital. This decision gets exacerbated since exact surgery durations are unknown in advance. To improve the utilisation of ORs and generate further revenue, hospital managers allow surgeons who do not work as their full-time employees (called outdoctors) to use ORs in their hospitals in return for a rental fee. Here, the outdoctors who regularly provide service in their own consultation offices or work for a smaller hospital without sufficient equipment support for some operations, are attracted by hospitals with high-tech equipment or specialising in specific areas that look for improving their revenues by renting out ORs to outdoctors. When outdoctors attempt to reserve OR times of a hospital, they have to compete for resources against the full-time surgeons employed by the hospital (called indoctors). This study considers the problem of assigning days to indoctor surgeries, selecting the outdoctor surgeries to be performed, and assigning days to selected outdoctor surgeries over a fixed planning horizon. We formulate a two-stage stochastic mixed-integer program for this surgery planning problem with an objective function, consisting of four competing criteria: total revenue generated through acceptance of outdoctor surgery requests, patient waiting time, expected OR overtime, and expected OR idle time. We develop and compare multiple scenario reduction-based approaches to obtain high-quality solutions in reasonable time limits using data from a large medical centre. The proposed approaches contain a loss function minimization-based scenario reduction phase

which can be solved by exact or heuristic approaches. After identifying the best performing approach, we conduct additional experiments that provide insights into the benefit of considering uncertainty in surgery durations, what percentage of OR capacity to be assigned to outdoctor surgeries, effects of surgery time windows on system efficiency, and how our proposed approach compares to well-known surgery planning heuristics in practice and in the literature.

A two-stage decision dependent stochastic approach for airline flight network expansion

Dr Ozge Safak[1], Dr Ozlem Cavus[2], Dr M. Selim Akturk[2]
[1]University of Bath, [2]Bilkent University

Parallel 1 - Optimisation under Uncertainty, Room 3.15, September 12, 2023, 09:15 - 10:45

Biography:

Ozge Safak is a lecturer in School of Management, University of Bath, UK. She joined the University of Bath as a prize fellow in 2019. She obtained her Ph.D. degree from Industrial Engineering at Bilkent University, Turkey in 2019. During her Ph.D. studies, she spent nine months as a visiting research scholar in Industrial Engineering and Operations Research at University of California, Berkeley in 2017. She also received her M.S. degree from Industrial Engineering at Bilkent University in 2013 and her B.S. degree from Industrial Engineering at Sabanci University, Turkey in 2011. Her research interests are applications of stochastic programming and second order cone programming, particularly focused on modelling and solving the various airline scheduling problems.

Airlines need to expand their flight networks with developing new routes and introducing more flights to increase their market share. In this work, we propose a two-stage stochastic mixed integer nonlinear program (MINLP), which expands an existing flight schedule by operating new flights either with existing fleet resources or a leased aircraft while considering the impact of departure time decisions on the probability distribution of random demand. Moreover, our study helps an airline to link a strategic decision of leasing an aircraft to the tactical aircraft assignment decisions by considering fuel efficiency and seat capacity of the aircraft alternatives in response to new passenger demand. However, the large number of scenarios, nonlinear fuel burn function and nonlinearities due to the decision dependent probabilities become main challenges of solving the problem. In order to deal with the computational requirements of a two-stage stochastic MINLP with decision dependent probabilities, we propose strong conic quadratic and McCormick inequalities, and an exact scenario group wise decomposition algorithm along with a new bounding method. In our computational results, we clearly demonstrate the effectiveness of proposed decomposition algorithm and the strength of the reformulations.

Robust retrofitting planning under endogenous uncertainty

Dr Xuan Vinh Doan[1]
[1]The University of Warwick, [2]The Alan Turing Institute

Parallel 1 - Optimisation under Uncertainty, Room 3.15, September 12, 2023, 09:15 - 10:45

Biography:
Dr Xuan Vinh Doan is a Reader in the Operations Group, Warwick Business School. He is currently a Turing Fellow at the Alan Turing Institute. Before joining Warwick Business School, he was a postdoctoral fellow in the Department of Combinatorics and Optimization at University of Waterloo, Canada. He completed his PhD from the Operations Research Center at MIT, his master study from the MIT-Singapore Alliance programme in Singapore, and his undergraduate study from RMIT University in Australia.

Retrofitting planning aims to strengthen strategic links in an infrastructure network, which is subject to failures due to disasters. The main focuses are network connectivity and post-disaster travel costs. In this talk, we propose a robust optimization framework to handle distributional ambiguity of decision-dependent random link failures in retrofitting planning. We analyze several properties of optimal solutions, which allows us to reformulate the problem as a mixed-integer linear optimization problem. Computationally, we propose a constraint generation method to solve the problem given the large number of potential scenarios. We analyze the tractability of the proposed approach and demonstrate it with numerical experiments.

Using the recourse space for scenario reduction in stochastic programming

Mr Hamish Thorburn[1], Dr. Anna-Lena Sachs[1], Dr Jamie Fairbrother[1], Professor John Boylan[1]
[1]Lancaster University

Parallel 3 - Optimisation under Uncertainty, Room 4.5, September 12, 2023, 14:45 - 15:45

Biography:
Hamish is a PhD Student at the STOR-i CDT at Lancaster University. His research interests are in stochastic programming for network design problems. He studied Mathematics and Statistics at undergraduate level at the University of Queensland, before working as a data analyst for the New South Wales Bureau of Crime Statistics and Research. He completed a Masters of Research at Lancaster University in 2020 before commencing his PhD studies.

Many important decisions in practice such as staff allocation, facility location or network design need to be made before all information is known. These problems are often solved using stochastic programming with a given scenario set to take uncertainty into account. Finding representative scenario sets for stochastic programming is key for finding good quality solutions within a reasonable time. We are interested in scenario reduction methods – methods which reduce a large scenario set to a smaller one. Often this reduction is done based on how similar the scenarios are. However, this can lead to suboptimal results, as similarity between scenarios does not guarantee similarity in how they respond to different solutions. We instead use recourse similarity of scenarios when using scenario reduction, to select more representative scenarios. We do this by transforming scenarios to the "recourse space" where distances between scenarios represent distances in recourse similarity. Here, we present our work transforming solutions to the recourse space to improve scenario reduction methods. We also apply this method to several practical problems and show how it can improve results.

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Inventory decisions to maximise survival probability subject to a joint service level constraint

Professor Thomas Archibald[1], Dr Zhen Chen[2]
[1]University of Edinburgh Business School, [2]Southwest University

Parallel 3 - Optimisation under Uncertainty, Room 4.5, September 12, 2023, 14:45 - 15:45

Biography:
Thomas Archibald is Professor of Business Modelling at the University of Edinburgh Business School. His research focuses on applications of stochastic modelling to problems in business and management.

Organisations with limited access to finance often need to prioritize effective cash-flow management over profit maximization. For example, this might be the case for start-up firms or SMEs unable to obtain loans due to a lack of credit history. At the same time, service level is an important factor for sustainability and growth. It follows that organisations must balance the ability to meet their financial commitments with the ability to meet customer expectations. This paper proposes a model to maximize the survival probability of a capital-constrained retailer subject to a minimum service level. Demand is assumed to be stochastic and non-stationary. A scenario-based method and a sample average approximation (SAA) method are developed to solve the model. A rolling horizon approach is proposed for problems with long planning horizons. Numerical results show that the rolling horizon approach together with the stochastic models can solve realistically sized problems in reasonable time.

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A multi-objective robust fuzzy model for food bank network design examining food nutritional value and freshness

Dr Javid Ghahremani-Nahr[2], Dr Abdolsalam Ghaderi[2], Dr Ramez Kian[1]
[1]Nottingham Trent University, [2]Department of Industrial Engineering, University of Kurdistan

Parallel 5 - Optimisation under Uncertainty, Room 3.1, September 13, 2023, 10:50 - 12:20

Biography:
Ramez Kian is a Senior Lecturer in the Department of Management. His main roles are delivering courses and supervision of PhD and Master's students in their research projects. He is experienced in applying mathematical modelling and operational research techniques to develop business solutions for problems mainly in operation management, supply chain and logistics area

To overcome food poverty, charities and food banks serve as the connection between beneficiaries and donors. They are mostly non-profit organizations while they incur operational costs for storage and delivery of the donated food items. The uncertainty of demand and supply is a challenge to overcome, which necessitates a robust plan.
The donated food items are either cold canned food, or hot meals from over production of businesses. Thus, their freshness, inventory and shelf-life causes additional operational challenges in distribution and logistics.
Our study proposes a multi-objective mathematical programming model for a food bank network design to optimize the cost, food freshness and its nutritional value. A robust fuzzy counterpart of the model is developed together with three solution methods including epsilon-constraint, MOGWO and NSGA II. According to our numerical study, the MOGWO algorithm shows a better performance in our with large instances. Its application on a case study resulted in a supply network with lower cost, smaller fleet size and higher food quality, although less fresh distributed foods compared to the benchmark network.
The trade-off between the cost and freshness of food is depicted here by examining shelf-life of products and vehicle capacity. The long lasting products incur less transportation cost due to compactness of packaging, and similarly, higher capacity vehicles lead to more cost efficient dispatch with longer routes which decrease the freshness of food.

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Stochastic Optimization Approaches for Truck-Drone Tandems in Humanitarian Applications

Mrs Hannan Tureci Isik[1]
[1]University of Bath

Parallel 5 - Optimisation under Uncertainty, Room 3.1, September 13, 2023, 10:50 - 12:20

Biography:
Hannan Tureci Isik is doing a PhD in Management at the University of Bath. She obtained masters and undergrad degrees from Industrial Engineering Department at Middle East Technical University, Turkey. Her research interests are decision-making under uncertainty, disaster relief operations and multi-criteria decision-making.

In this study, we consider drones together with trucks for relief distribution in the aftermath of a disaster. Drones can overcome the inaccessibility problem on distrupted road networks and deliver light-weight humanitarian aid items like vaccine and first aid kits etc. We propose a two-stage stochastic programming model to locate depots prior to a disaster considering the subsequent post-disaster relief distribution by routing trucks and drones independently from depot, considering uncertainty on the road network. Due to the complexity of problem, we can only solve small problems with limited scenarios optimally. We develop a Variable Neighborhood Search based heuristic to solve the problem for larger instances with many disaster scenarios.

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A Cutting Plane Method for Bilevel Facility Interdiction Problem with Stochastic Damage

Dr Mahdi Noorizadegan[1], Prof. Abbas Seifi[2]
[1]Northumbria University, [2]Amirkabir University of Techology

Parallel 9 - Optimisation under Uncertainty, Room 4.10, September 14, 2023, 11:00 - 12:30

Biography:

Dr. Mahdi Noorizadegan is a senior lecturer (Assistant Professor) in Operations and Supply Chain Management at the Department of Operations, Marketing and Systems. Prior to the current position, Mahdi was a faculty member in Niroo Research Institute, Tehran, Iran. Mahdi did his Bachelor and Master's degrees in Industrial Engineering in Amirkabir University of Technology, Iran. He received his PhD on Operational Research and Management Science from Warwick Business School and the Centre for Discrete Mathematics and its Applications (DIMAP), the University of Warwick, UK.

This paper presents a bilevel model for a facility interdiction problem with single-sourcing allocation and stochastic damage. The upper level of our bilevel model represents the attacker problem whose objective is to cause maximum damage to the defender's supply network by attacking a set of facilities subject to his budget constraint. At the lower-level problem, the defender seeks to meet all demand with minimum cost subject to capacity constraints and uncertain damage occurred to the facilities. The defender would have two strategies to deal with attacks: reliability and cost-based strategies, formulated as chance constrained and two stage stochastic models, respectively. The lower-level problem, regardless of the strategy, is a non-convex cost function with respect to the attacker's decision. To solve the integer bilevel problem, we propose a set of optimality cuts to represent the defender's problem in the attacker's problem. To enhance the performance of the proposed method, the second type of cuts is introduced based on the notion of dominance which removes dominated solutions from the search space of the attacker's problem. The paper concludes with an extensive numerical experiment to demonstrate the computational efficiency of the proposed approach and analyze the sensitivity of attack decisions with respect to key parameters such as cost and reliability level.

Pairwise comparisons method with insufficient information

Jiri Mazurek[1]
[1]Silesian University in Opava

Parallel 9 - Optimisation under Uncertainty, Room 4.10, September 14, 2023, 11:00 - 12:30

Biography:
Jiri has been an assistant professor at the Department of Informatics and Mathematics, School of Business Administration in Karvina, Silesian University in Opava, Czech Republic, since 2009. He teaches courses in quantitative methods, mathematics and statistics. His research focuses mainly on multiple-criteria decision making methods, pairwise comparisons methods and decision making under uncertainty. He published his research in journals such as European Journal of Operational Research, International Journal of Approximate Reasoning, or IEEE Access. He is a member of various Czech, European, American and UK societies of operational research.

Pairwise comparisons constitute a crucial part of many multiple-criteria decision making methods such as the analytic hierarchy process (AHP). When comparing n objects pairwise, at least (n − 1) comparisons have to be performed
for a derivation of a priority vector (vector of weights) by a suitable prioritization method such as the eigenvector method or the geometric mean method. The aim of the paper is to introduce a novel method (procedure) for the cases with insufficient information, that is cases when the number of known (available) pairwise comparisons ranges from 1 to (n−2). The method provides iteratively a probability of each possible ranking (permutation) of all compared objects based on the (so far) revealed pairwise comparisons. The method's output consists of ranking probabilities and interval weights of each compared object.

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OR for Strategic Decision Making and Policy Making

Critical Thinking Skills Enhancement through Systems Thinking and System Dynamics-assisted Games: Preliminary Insights from the PMBoG Project

Professor Federico Barnabè[1], Dr Stefano Armenia, Dr. Alessandro Pompei, Dr. Sarfraz Nazir
[1]University of Siena

Parallel 1 - OR for Strategic Decision Making and Policy Making, Room 4.16, September 12, 2023, 09:15 - 10:45

Biography:
Federico Barnabè, Ph.D., is Full Professor in Business Administration at the Department of Business and Law, University of Siena (Italy). Previously, Federico was a visiting researcher at the University of Bergen (Norway) and Roehampton University (UK). His main research interests include management accounting, performance measurement, accounting history, and simulation & gaming. He published in several international journals on these topics. He was Co-Editor of the Rivista di Contabilità e Cultura Aziendale, and Guest Editor for the journals Kybernetes, Journal of Modelling in Management, and Journal of Simulation.

This study explores the role of Systems Thinking and System Dynamics-assisted games in enhancing critical thinking skills in learners. In more detail, the study relies on the use of an SD-based Interactive Learning Environment related to project management issues, followed by Systems Thinking-supported debriefing sessions. The ILE was developed and used in the form of a single-player, online computer-based game. The game was developed in order to mimic all the necessary panning and operational activities needed to organize a wedding. The acquisition of critical thinking skills in learners was assessed in three main ways: 1) players' performance were analyzed through a scoring system embedded in the game that takes into account several performance dimensions; 2) feedback from the players were collected and analyzed. In detail, players were interviewed and required to describe their learning experience, the strategies they used during the game and the perceived learning points of such experience. Players' feedback was subsequently investigated using basic content analysis principles; 3) players' performance were analyzed using the five categories of structures identified by Lyneis and Ford (2007). Specifically, this last stage of the process heavily relied on the use of Systems Thinking principles and tools in order to let players' heuristics identified and subsequently analyzed. Preliminary results and findings show that

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the joint use of System Dynamics and Systems Thinking tools and principles within a gaming environment has the potential to facilitate and enhance critical thinking skills acquisition in learners.

Telecom Player's Expansion into Ad-Tech under Competition and Cooperation with Content Provider

Dr. Rajeev Ranjan Tripathi[1], Dr. Sudha Madhavi Dastrala[2]
[1]Indian Institute Of Management Bangalore, [2]Great Lakes Institute of Management

Parallel 1 - OR for Strategic Decision Making and Policy Making, Room 4.16, September 12, 2023, 09:15 - 10:45

Biography:
Rajeev R. Tripathi is an assistant professor in the Production and Operations Management Area at the Indian Institute of Management Bangalore. He obtained his Ph.D. from the Indian Institute of Technology Madras. His primary research interests are in cooperative game theory, competitive and cooperative strategies in operations management, and platform business models. His research work has been published in leading journals such as the European Journal of Operational Research, the Journal of the Operational Research Society, and the Operations Research Letters. His research articles have also received best paper awards at multiple conferences such as the PAN IIM World Management Conference and the Annual International Conference of the Society of Operations Management. Prior to joining IIMB, he worked as a senior analyst at Ford Motor Company in Chennai. At Ford, his interests were in advanced operational analytics, smart mobility, and enterprise risk.

The basic premise of this paper is a telecom player's expansion into ad-tech services, in relation to a content provider who depends on the telecom player for network services. The content provider offers digital content to end-users under an ad-supported subscription plan. Under this plan, users are required to pay a nominal subscription fee in order to access content that includes a few advertisements from advertisers. An ad-tech provider offers advertisers marketing insights and analytics. Advertisers have the option to receive these ad-tech services either through a telecom player or a third-party ad-tech provider.

Alternatively, advertisers can choose to directly approach the content provider, but in doing so, they would miss out on the advantages of the ad-tech services. Using game-theoretic modeling, we derive conditions under which a telecom player behaves as a network provider, an ad-tech provider, or both. We also explore if the telecom player should compete or cooperate with the content provider if entering into the ad-tech market.

Further, we study the implications of a telecom player's expansion into the ad-tech business for third-party ad-tech providers and content providers. Our preliminary analysis shows that in the case when a telecom player shares its ad revenue with CP, costliness to quality and fit cost influence the performance of the CP and the telecom player. We further find that as more and more advertisers reach out to the telecom player, the ad revenue share increases,

indicating that the telecom player would like to keep CP in good books. Under certain conditions, the additional role of the ad-tech service provider is beneficial to the telecom player. However, in the duopolistic ad-tech market situation, there are certain conditions under which the third-party ad-tech provider earns better than the telecom player, indicating that the telecom player must avoid entering the ad-tech market.

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Wireless 2030: A scenarios analysis of public service demand for wireless connectivity in 2030

Dr Sion Cave[1], Dr David Exelby[1]
[1]Decision Analysis Services Ltd

Parallel 6 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 13, 2023, 16:00 - 17:00

Biography:
Head Decision Analysis Services Analytics + Foresight Hub

Wireless connectivity has become increasingly critical for different aspects of our lives, from keeping in touch, to getting around, to accessing a range of important services. Dr Siôn Cave will describe a Futures project undertaken in 2022 which explored the critical uncertainties around demand for wireless connectivity and the implications for delivery of wireless public services out to 2030. These uncertainties were combined into a set of quantified scenarios that are being used to help develop more resilient policies.

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Scenarios and System Dynamics

Professor Martin Kunc[1]
[1]Southampton Business School

Parallel 6 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 13, 2023, 16:00 - 17:00

Biography:
Professor of Management Science/Business Analytics. Co-editor in chief of Journal of the Operational Research Society. Interests in strategic modelling, behavioural science, scenarios and system dynamics

System dynamics is a methodology to generate qualitative and quantitative models considering two main aspects of systems that feedback processes define the structure of the system and accumulation processes reflect its dynamic behaviour over time. This article discusses on methodological synergies that may originate by pairing scenarios and system dynamics. The pairing can take multiple forms: a simulation model to test scenarios, a qualitative model to represent and understand the structure of the system (as suggested in augmented logics), a simulation model to create scenarios, or a management flight simulator to immerse decision makers into scenarios. The pairing is illustrated with multiple examples from practice. Since system dynamics' practice uses processes that are similar to scenario practice, mutual enrichment between the communities can be highly successful.

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Coarse-graining for strategic decision-making

MSc Stefan Salome[1], PhD Willem Auping[2]
[1]Copernicos, [2]Delft University of Technology

Parallel 7 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 13, 2023, 17:00 - 18:00

Biography:
Stefan is an external PhD candidate at the faculty of Technology, Policy and Management at Delft University of Technology. His position is funded by Copernicos, a Dutch consultancy that applies (System Dynamics) modeling & simulation to support decision-making of primarily public organizations.

Stefan's PhD research focusses on the development of coarse models that are aligned with detailed models that are in use by Dutch organizations. The idea is to support decision-making under deep uncertainty. The coarse models enable massive computational experimentation, and the alignment with detailed models enables the analyst to verify the plausibility of outcomes of interest and to develop concrete policies. The cases are located in the asset management domain, the water domain, and the transport and logistics domain.

Many governments, NGOs, and businesses use vastly sized simulation models to support strategic decision-making. However, detailed models generally have a low computational speed, flexibility in usage, and transparency of results. In the case of strategic decision-making, this is problematic. Strategic decision-making deals with a long-term future that is inherently uncertain. When confronted with irreducible or 'deep' uncertainty, models must allow massive computational experimentation to explore the consequences of varying assumptions and hypotheses. This requires models to be fast, flexible, and transparent to the user. To achieve this, models must have a relatively small size. One way to reduce the model size is with coarse-graining. With coarse-graining, one decreases the granularity of a model. In our research, we coarse-grained a detailed model to a new (System Dynamics) model. The detailed model is used by a Dutch organization for strategic decision-making about the design, support, and use of naval assets. The model contains an elaborate component design structure and distinguishes many types of maintenance crews and operations. However, because of its high computational and analytical burden, the model is not suitable for exploratory analysis. This is needed, because uncertainty revolves around the asset design (e.g., ageing or failure properties), the support system (e.g., the availability of human resources for maintenance), and the environment in which the asset is operating (e.g., the lead time or load of an operation). Unlike the detailed model, the coarse model enabled (a) massive sampling from the uncertainty space, and (b) extensions in model scope. This was helpful in understanding the consequences of previously untested

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assumptions in the detailed model, e.g., about certain phenomena being constant or static. The coarse model also made it possible to explore robust policies. A limitation of the coarse model is that it runs the risk of producing too abstract or naïve outcomes due to the information loss from coarse-graining. This hinders the acceptance of the model for policy analysis. Further research is needed into the alignment between models with different granularities, so that findings with a coarse model can be translated to better understandable concepts in a finer-grained model.

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Governance, Monitoring and information asymmetry: the role of big data analytics in pension fund governance

Mr Georgios Karamatzanis[1], Prof Kostas Nikolopoulos[1], Dr Anna Tilba[1]
[1]Durham University Business School

Parallel 9 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 14, 2023, 11:00 - 12:30

Biography:
I am a PhD candidate at the department of Management & Marketing at Durham University Business School. My research focuses on corporate governance, data analytics, and the impact of technology on the board of directors. I am particularly interested in LegalTech and pension fund governance. I am also a teaching assistant at Durham University Business School and the manager of the Institute of Hazard, Risk, and Resilience forecasting lab.

Through the agency theory lens, we study if and how big data analytics and technological tools can improve pension fund governance to allow trustees to use available information more effectively. We theorise how big data analytics and technological tools could help reduce information asymmetries, improving decision-making by giving trustees a better insight into assessing their pension funds' governance, administration, and investment plans. Further, we propose that this can improve governance by reducing information asymmetry arising from the agent-principal relationship and allowing trustees to be better monitors and achieve greater transparency, improving the funds' administration. In the context of the lack of research on using big data analytics and other tools in dealing with information asymmetries, which is assumed by agency theory that trustees should be doing, we explore the impact of technological tools on the double agency relationship in pension fund governance. Empirically, it is an interesting issue to explore as the literature suggests that improved monitoring could reduce costs. Due to trustees being both principals and agents, the question of whether they behave as they should in practice arises. This is particularly important in this context as effective pension fund governance can and does play a crucial part in determining millions of savers' financial future in the UK and globally. We will also consider the high transaction costs pension funds are paying and how these can be lowered to benefit pension fund members. The practical implication of our paper is that by exploring the above relationships, we aim to improve pension fund governance and trustee oversight.

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Design of a Framework and Visualisation Tool to Evaluate Stakeholder Engagement

Dr Richard Jackson[1], Philippa Johnson[1]
[1]Decision Analysis Services Ltd

Parallel 9 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 14, 2023, 11:00 - 12:30

Biography:
Richard is a Senior Strategy Consultant at Decision Analysis Services with cross-sector experience in the application of Systems Thinking, Mapping and Modelling approaches to support strategic decision making.

Philippa is a Data Scientist within the Analytics and Foresight Hub at Decision Analysis Services. She has an interest in the modelling and visualisation of complex datasets.

DAS was commissioned by an organisation to create a tool that presents a shared view of their external stakeholders. The principal use case was to identify required action with priority stakeholders when the relationship "health" needs improving. DAS worked with the organisation to design a stakeholder evaluation framework, which was used to assess the connectivity, strategic alignment, and health of engagement with external stakeholders. Data pertaining to the evaluation framework metrics were then collected through interviews and questionnaires. This data was stored in an Excel database and presented visually on a Power BI Dashboard via Power Query. The Dashboard is multi-functional, containing features including:

- Maps of stakeholder engagement which can be filtered by Team and strategic objective
- Identification of priority stakeholders
- Flag of priority stakeholders where the fulfilment of relationship is low, and reasons for this
- Listing potential opportunities for additional engagement which can enhance delivery of strategy

The recommended framework, data gathering process and Power BI Dashboard is being implemented by the organisation to improve their stakeholder engagement processes.

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Development of an Energy Profits Levy for HMG during a Global Energy Crisis

Mr William Waller[1]
[1]HMRC

Parallel 9 - OR for Strategic Decision Making and Policy Making, Room 3.5, September 14, 2023, 11:00 - 12:30

Biography:
William Waller is a senior analyst in Oil and Gas Receipts forecasting and analysis at HM Revenue and Customs.

Following record high oil and gas prices over the previous year, on 26 May 2022 the former UK Chancellor announced the Energy (Oil and Gas) Profits Levy (the EPL). Widespread media attention on the record profits being made by energy companies and strong political pressure meant that its design and implementation had to be done at speed. It was also important to produce a levy that, whilst helping fund cost of living support for UK families would not dampen investment in the North Sea. This was required so that it aligned with the UK's overall oil and gas fiscal regime, designed to attract investment into the basin. And this helps achieve the Government's goal of Maximising Economic Recovery (MER), ensuring the nation receives a fair return for its natural resources. This paper discusses the considerations needed in the design to meet these demands. It required an analysis of how companies evaluate commercial viability of new projects, incorporating this in the design of the new tax and related allowances. It outlines how HMRC's existing forecasting model was adapted to cost the revenues expected from the Levy, the main concerns of different stakeholders and how these were built into the final version. Changes to the EPL were made at the 2022 Autumn Statement and these are discussed briefly along with a look ahead to possible next steps post EPL.

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From modelling to creativity

Dennis Sherwood[1]
[1]The Silver Bullet Machine Manufacturing Company Limited

Parallel 10 - OR for Strategic Decision Making and Policy Making, Room 3.1, September 14, 2023, 14:30 - 16:00

Biography:

Dennis Sherwood runs now runs his own consulting business, Silver Bullet, having been a consulting partner in Deloitte, Haskins + Sells (a predecessor of PwC) and an Executive Director at Goldman Sachs.

Dennis is the author of many articles and blogs, the co-author of three books (including 'How to be Creative - A practical guide for the Mathematical Sciences, co-authored with Professor Nicholas Higham FRS FREng, and published by SIAM), and sole author of twelve others, including 'Seeing the Forest for the Tress - A manager's guide to applying systems thinking' (Nicholas Brealey, 2002), 'Strategic Thinking Illustrated - Strategy made visual using systems thinking' (Routledge, 2022), which was short-listed in the 'Specialist Business Book' Category of the 2023 UK Business Book Awards, and 'Creativity for Scientists and Engineers' (Institute of Physics, 2022), which beat my other book by winning the 'Specialist Business Book' Category!

OR and business analytics are certainly vital in supporting the implementation of strategy - to quote some words from the description of this stream.

Those words are important, and carry a significant message, especially the word 'support' - with the implication that OR and business analytics play a role, but are not the complete story.

I think that limitation is wise, for there is another major contributor too - creativity, the generation of great strategic ideas.

Throughout my career, I have straddled the domains of OR/ business analytics (especially systems thinking) and creativity, so I'd like to take the opportunity of this session to describe my approach to creativity, to show how it relates to more formal OR/business analytics, and - most importantly - to make the case that being skilled in 'deliberate creativity' and 'wise evaluation' should be part of every OR/business analytics practitioner's tool kit.

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Analytics and the strategy development process

Dr Frances O'brien[1]
[1]Warwick University

Parallel 10 - OR for Strategic Decision Making and Policy Making, Room 3.1, September 14, 2023, 14:30 - 16:00

Biography:

Frances is an Associate Professor of Operational Research at Warwick Business School and a Fellow of the OR Society. She has research, practitioner and teaching experience in the development and use of frameworks, modelling and analytical approaches to supporting organisational strategic development. In particular her research explores the development and use of scenario planning for assessing future uncertainty and visioning approaches for developing organisational direction. She has consultancy experience working with senior management teams in education, recruitment and not-for-profit sectors. She is actively involved in the WORAN (Women in OR & Analytics Network) of the OR Society.

Strategy is something an organisation both has and does. Developing strategy is identified as an organisational process consisting of a number of activities inter alia setting strategic direction, assessment both internal and external environments, formulating and evaluating strategic initiatives and options and monitoring and evaluating performance and progress towards goals.

At OR55, I and a colleague presented a paper proposing how Analytics might be used to support a strategy development process. We followed up this research with a survey of the literature which was published in JORS. The purpose of this paper is to revisit this topic and present the research of an updated literature review of the use of Business Analytics to support the process of strategy development.

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A Multi-Objective Optimization Framework for Effective Cross-Sectoral Policy Making to Improve Population Health and Reduce Health Inequalities

Mrs Shraddha Ghatkar[1], Dr João Duro[1], Dr Emma Comrie[2], Dr Ping Li[1], Prof Visakan Kadirkamanathan[1], Prof Robin Purshouse[1]
[1]University Of Sheffield, [2]Public Health Scotland

Parallel 10 - OR for Strategic Decision Making and Policy Making, Room 3.1, September 14, 2023, 14:30 - 16:00

Biography:
Shraddha Ghatkar is a Research Associate in the department of Automatic Control and Systems Engineering at the University of Sheffield. She works in Work Strand 7 (Economic Models and Decision Support) of the The SIPHER (Systems Science in Public Health and Health Economics Research) Consortium.

It is one of the important issues for a government body to introduce effective policies for promoting health and wellbeing in their population. The SIPHER (Systems Science in Public Health and Health Economics Research) Consortium is proposing a Decision Support Tool (DST) that helps budget holders to identify where to target policy action. The DST has a multi-objective optimization problem formulation in its framework since many policy goals tend to be in conflict with each other. The complex relationships between economic factors and health outcomes like healthy life expectancy (HLE) and health inequalities have been captured by a systems map that is characterised by different nodes and relationship arcs. The nodes can be stimulated by making a policy action and the effects of this action can be observed on the entire system over time. To evaluate the different stimulus options, an Inclusive Economy Dynamical Systems model has been integrated into the tool. By changing the magnitude of stimulus points on the nodes of the systems map, the DST aims to find action options that simultaneously maximise the average HLE of the population, minimise the inequality in HLE, and minimise the total cost of intervening. A Pareto-based evolutionary algorithm has been employed in the DST to find a set of contrasting solutions to provide the users with trade-off options. The DST has a user interface where policy configuration boundaries can be changed for the desired computational run and the solutions can be explored interactively. The DST is being trialled with policy partners to understand the barriers and facilitators to uptake, and to develop requirements for new iterations of tool development.

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Optimal Portfolio of Binary Assets Using Nonparametric Predictive Inference

Mr Mohammed Alhanif[1], Prof. Frank Coolen[1], Dr. Tahani Coolen-Maturi[1]
[1]Durham University

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Mohammed Alhanif is a PhD student in Durham University. The thesis title is Portfolio theory from nonparametric predictive inference perspective. He did a master of financial mathematics in University of Wollongong, Australia, and a bachelor of mathematics in Teaching College, Saudi Arabia. He works as an assistant lecturer at King Faisal University, Saudi Arabia. He has one publication, in Arabic, titled with Mohamed Sadok Cherif and Nabil Mansour. The paper is presented in Arabic and it is titled as "A Goal Programming Model with Satisfaction Functions for Portfolio Selection in Saudi Stock Market".

Portfolio optimization refers to the process of creating an investment portfolio that achieves an optimal balance of expected risk and return. Inferences about the future performance of a portfolio are typically quantified with the use of parametric distributions and single-valued probabilities. Imprecise probability is a generalization of classical probability theory, enabling various less restrictive representations of uncertainty. Nonparametric Predictive Inference (NPI) is one of the statistical methodologies that is developed to quantify uncertainty using imprecise probabilities, and it is based only on an exchangeability assumption for past and future observations. NPI is a frequentist statistics framework that uses lower and upper probabilities and has attractive properties from several perspectives. NPI is developed for binary data, and applied to several topics, such as system reliability. Recently, NPI has been introduced to some problems that are related to single binary assets. In this paper, we introduce NPI to the problem of portfolio optimization of binary assets. We develop a portfolio optimization approach that focuses on finding a balance between the probability of achieving successful outcomes and the potential for encountering failure outcomes. The problem is designed in the form of a knapsack problem and it is solved by heuristics. First, we consider the problem at a different level of desirable (potential) number of successes (failures) and find the optimal allocation for each scenario. We find that the optimal portfolio is more diversified in the cases of small levels and so concentrated otherwise. Second, we incorporate cost-budget constraint with constant and variable costs cases. We find the optimal portfolio that meets these constraints. Our NPI imprecise probabilities of successes (failures) are conservative and could address the issue of overestimating (underestimating) the probability of success (failure) in the classical Kelly criteria. We are conducting an ongoing comparative analysis with existing studies to assess our novel NPI portfolio optimization approach.

Keywords: Binary assets; heuristics; imprecise probability; knapsack problem; nonparametric predictive inference (NPI); portfolio optimization; uncertainty.

OR in Health and Social Care

KEYNOTE: Where's the Beef – When will OR deliver for health and care?

Prof Martin Pitt[1]
[1]University of Exeter: Medical School

Parallel 1 - OR in Health and Social Care KEYNOTE: Martin Pitt, Room 4.1, September 12, 2023, 09:15 - 10:45

Biography:

Professor Martin Pitt is Director of PenCHORD - The Peninsula Collaboration for Health Operational Research and Development. PenCHORD is part of the NIHR funded SW Applied Research Collaboration (ARC) at Exeter University: Medical School. It is a research team which works in close collaboration with NHS organisations in the south-west of the UK to improve health and care delivery using OR approaches. PenCHORD is also fronts the SW ARC as the lead organisation for Operational Research within the national ARC network. Martin's early academic background was in psychology, cognitive science and human-computer interaction. He joined Exeter University in 2003 during which time he helped establish and now co-ordinates MASHnet - The UK Network for Modelling and Simulation in Healthcare. Martin has a long-standing and wide ranging experience in healthcare modelling ranging from economic modelling in health technology assessment to discrete event simulation and operational models for service re-design. His research interests are broadly the application of modelling techniques and data science to improve health and care with a particular interest in the implementation of these approaches to policy and decision making process. He has a specific research focus on use of visualisation techniques to improve the accessibility of information for key stakeholders in the NHS. He has been centrally involved in the establishment of a new MSc programme in Health Data Science at Exeter University funded by Health Data Research UK and was recently appointed as first President of the Association of Professional Healthcare Analysts (AphA) the organisation which represents health service analysts across the NHS.

The last three decades of my research career has been devoted to bridging the chasm between the academic/research community and health/care services. Depressingly, it often seems that little if any of the insights and outputs from OR make their way into meaningful application to improve delivery. Understanding the barriers and causes of this short-fall is central to overcoming the implementation gap.

This presentation will draw on the experiences and understanding gained from many years addressing these issues referencing the work of the UK Modelling and Simulation Network (MASHnet) and the research activities of the Peninsula Collaboration for Health Operational Research and Data Science (PenCHORD) based at the University of Exeter.

I will outline, across key dimensions of interest, the core reasons for the current lack of successfully implemented and sustained OR solutions within health and care services. Current progress will be outlined giving some grounds for optimism. Finally some tentative recommendations will be offered for improving the transfer of solutions from OR across to health services so that the benefits can be fully realised. A panel discussion will follow this presentation to encourage audience engagement.

Impact on the Waiting List from Optimising Elective Care Pathways using Discrete Event Simulation

Dr Suchi Collingwood[1], Mrs Sandra Rochfort[1], Mr Simon Wellesley-miller[1]
[1]NHS England

Parallel 2 - OR in Health and Social Care, Room 3.1, September 12, 2023, 13:15 - 14:45

Biography:
Suchi leads on analytical projects which involve modelling the elective waiting list to inform the post-pandemic recovery of NHS services. Suchi is passionate about using Operational Research techniques and approaches to drive change for the better and incorporate diverse perspectives. She has a PhD in OR and worked in several Government Departments before joining NHS England. She also supervises student projects on the Business Analytics and Decision Sciences Masters at Leeds University, and has previously been a member of various OR Society Committees and the Board. Suchi has a 3-year old who occupies much of her time outside of work, but enjoys getting outdoors with any spare time.

Simon has been an Analyst working in health and social care for 14 years and is keen on using robust statistics and operational research methods to healthcare issues. He currently is working in the South West Performance Analytics Team and also the National Elective Recovery Insights Cell. He has recently completed a MSc in Healthcare Data Science at Exeter University. He is also the lead for the South West branch of the Association of Professional Healthcare Analysts and a fellow of the NHS R community. In his spare time loves running and is a massive geek playing dungeons and dragons.

In England, elective care covers a broad range of non-urgent health services, and the COVID-19 pandemic has led to a backlog of patients waiting for care. A key priority for NHS England is to support the restoration of elective performance over the longer term and the Elective Recovery Plan sets key targets to March 2025. These involve tackling long waits and expanding capacity for diagnostic and treatment.

This project aims to understand the potential for using resources differently to care for patients referred for a consultant-led pathway, and the impact of this on the size and shape of the waiting list of those patients. It also aims to understand the impact on the capacity to provide care to other patients in other areas of elective care.

The work will bring together various analysis and modelling. It will utilise key administrative datasets available within NHS England, namely: the Secondary Uses Service, a record-level dataset containing information on activity taking place in secondary care in England; and the

Waiting List Minimum Dataset, which is a pathway-level dataset containing information on both open and completed pathways.

First, we will use process mining techniques on SUS data to establish activities along pathways, test hypotheses on optimising elective care pathways, and determine capacity assumptions. Second, demand modelling using forecasting techniques will be linked in.

Last, a discrete event simulation will be created to test the impact of different pathway prioritisation rules, adjustments to the amount of activity per pathway, and future demand and capacity assumptions. Utilising NHS England's unique position to see data from across the entire country, outliers in practice, good practice, and bottlenecks, will be identified.

Scenarios will be modelled to support operational and strategic change in line with the Elective Recovery Plan ambitions. The results of the project will support planning and investment decisions ensuring resources are used as efficiently as possible as well as understand clinical variation.

This talk will outline the progress to date and cover key aspects of problem formulation and structuring.

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Using linked health data for quality improvement in services for congenital heart disease: the pain and the pay-off

Miss Julie Taylor[1], Professor Christina Pagel[1], Professor Sonya Crowe[1], Dr Ferran Espuny Pujol[1]
[1]University College London

Parallel 2 - OR in Health and Social Care, Room 3.1, September 12, 2023, 13:15 - 14:45

Biography:
Following a degree in Zoology at University of Wales-Bangor, Julie completed her training to become a HCPC registered Biomedical Scientist in histology. Whilst working in biomedical science, Julie completed her MSc in Epidemiology at the London School of Hygiene & Tropical Medicine before taking a Research Assistant post at the Gynaecological Cancer Research Centre, UCL in 2014. From January 2017 she worked on the British Women's Heart and Health Study at the Institute of Health Informatics, and joined CORU in March 2018 as the study coordinator for 'Linking audit and national datasets in congenital heart services for quality improvement' (LAUNCHES). In April 2021, Julie joined CORU permanently as a Senior Research Coordinator, working on LAUNCHES, the CHAMPION study (Congenital Heart Audit: Measuring Progress In Outcomes Nationally) and CHIMERA (Collaborative Healthcare Innovation through Mathematics, EngineeRing and AI).

Background
Linking datasets from clinical and national audits, national registries, and other NHS encounter data can help us to understand current NHS service provision better and support quality improvement. But data linkage studies are notoriously time-consuming, with delays often extending years.

We describe our experience of accessing, linking and maintaining the use of five national datasets for a research project focusing on improving services for congenital heart disease ("LAUNCHES"), including the complex processes and the vast time and resources involved. The pain does have pay-offs though and we end by presenting some interesting results generated using this unique data source.

Methods
The LAUNCHES dataset comprised all records from the National Congenital Heart Disease Audit from April 2000–March 2017, defining a population of patients who had undergone at least one procedure for congenital heart disease. Patients were matched to records in the Paediatric Intensive Care Audit network, Intensive Care National Audit and Research Centre–Case Mix Project, Hospital Episode Statistics and Civil Registrations mortality data.

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Results

The study set up began in March 2018. It took 1 year and 8 months to obtain all necessary approvals from university processes, ethics, the Confidentiality Advisory Group, and approvals and data from data controllers. Amendments in scope, changes to the team and project extensions all required new permissions involving an additional 9 documents/applications each time. Annual renewals/reports also added significant workload.

Repurposing the linked data for a new, related project, required the entire process to be repeated from scratch, taking 10 months to obtain initial approvals and between 1 to 9 further months for approvals to use the data we already held.

The linked dataset facilitated the analysis of longitudinal patient trajectories through the health care system for seven congenital heart conditions, including healthcare utilisation and outcomes of ventricular septal defect within the first two years of life.

Implications

The current processes for accessing and linking national datasets is time consuming, complex, and iterative. We aim to contribute to the national conversation on how to balance the justifiably stringent data protection and governance with the potential opportunity for beneficial research.

Data analysis of multimorbidity in Brazil

Dr Simone Lima, Dr Caroline Mota
[1]Federal University of Pernambuco

Parallel 2 - OR in Health and Social Care, Room 3.1, September 12, 2023, 13:15 - 14:45

Biography:
PhD in Management Engineering from the Federal University of Pernambuco - UFPE/PPGEP (2022). Visiting PhD student at Manchester Metropolitan University (MMU). Master in Management Engineering and Bachelor's Degree in Business Administration (UFPE). Member of the Project Management and Development research group (PMD/UFPE/PPGEP).

Multimorbidity is a global concern in primary health care. It is usually defined as the co-occurrence of two or more chronic conditions in the same individual. Data analysis strategies such as cleaning, organizing, and modeling data were explored to extract useful patterns that could support data-driven decisions. Trends in the prevalence of multimorbidity were investigated, considering the socio-demographic, geographic and health-related characteristics of Brazilians from a temporal perspective. We evaluated different cross-sectional national-based surveys, including the National Sample Household Survey (PNAD) and the Brazilian National Health Survey (PNS). For instance, it was observed that patients with long-term and multiple chronic diseases tend to consider their health worse, needing more health assistance and hospitalization compared with people without chronic illnesses. These trends are similar and confirmed across all cohorts analyzed. Viewing patterns can support policy-makers in different types of interventions aimed at improving prevention strategies. Analyzing a large amount of data by looking at multiple time periods is still a challenge and research is needed to monitor chronic diseases, which are among the leading causes of death worldwide.

Fair Healthcare Commissioning: integrating efficiency and distributional fairness in resource prioritisation

Dr Nikolaos Argyris[1], Dr Özlem Karsu[2], Mirel Yavuz[3]
[1]Loughborough Business School, Loughborough University, [2]Department of Industrial Engineering, Bilkent University, [3]Anderson School of Management, University of California at Los Angeles

Parallel 3 - OR in Health and Social Care, Room 3.1, September 12, 2023, 14:45 - 15:45

Biography:
Nikos Argyris is Senior Lecturer in Operational Research in Loughborough Business School at Loughborough University. He previously held posts at the Department of Statistics of University of Warwick and the Department of Management of London School of Economics and Political Science, where he completed his doctoral studies.

Nikos' research is at the interface of Operational Research and Economics, with emphasis on integrating models of decision making with computational techniques, to design frameworks for decision support. His research on these topics has been published in the leading journals in the field. Nikos has being involved in several projects supporting Governmental/Public-Sector decisions in Education, Health and Emergency Management. His current work focuses on the design of frameworks to integrate distributional equity in public resource allocation mechanisms, and on the measurement of social progress based on multiple societal goals, beyond economic measures.

We present a framework which can be used to support healthcare commissioning decisions. This is based on complementing information on cost-effectiveness of different interventions with the associated impact on the distribution of health across the population. This enables stakeholders to consider both efficiency and fairness in their decision making. The trade-off between these two aspects depends on the degree to which stakeholders are averse to distributional inequalities. We introduce a mechanism via which we can model the degree of inequality aversion and use it to prioritise interventions (via optimisation) for different degrees of inequality aversion. This identifies exactly the impact of the degree of inequality aversion on efficiency (total health) and on the distribution of health across the population, thus illuminating the associated trade-off for decision makers.

Predicting long-term population health trajectories and related capacity and cost requirements: a modelling approach

Dr Zehra Onen Dumlu[1], Dr Richard Wood, Prof Christos Vasilakis
[1]University Of Bath

Parallel 3 - OR in Health and Social Care, Room 3.1, September 12, 2023, 14:45 - 15:45

Biography:

Zehra Önen-Dumlu is a research associate at the University of Bath School of Management in the Information, Decisions and Operations division. She earned her Ph.D. in Industrial Engineering and Operations Management from Koç University. Her research interests focus healthcare operations management. She is mainly interested in developing and investigating models under uncertainty that will help improve healthcare operations and global health systems.

Healthcare policy makers face regular challenges on how to allocate healthcare resources with limited budgets, both in the short and longer term. Mathematical and computer modelling tools can capture, subject to assumptions and simplifications, these interacting factors in estimating the long-term trajectory as well as the implications of different mitigatory measures. We developed a mathematical model and accompanying simulation tool to support decisions around long-term commissioning needs for a large healthcare system in the Southwest of England.

The model is two-fold. First, we developed a finite horizon discrete-time Markov chain where the state space representing the health state of individuals within the population is based on segmentation using Cambridge multimorbidity index. Data were obtained from the System Wide Dataset, which provides patient-level linkable data including primary care, secondary care, mental health, and community services data for over 1 million population. Essentially, the model accounts for the life-course of individuals as they age and (typically) advance through the states with declining health. Such movements are extrapolated from the observed transition rates in years 2020 through 2023, anchored on demographic projections (births, deaths and migration) from the Office for National Statistics. Second, activity and cost outcomes of different points of delivery levels (e.g., 111/999 activity, primary care and secondary care visits) per core segment are estimated based on population projections. A simulation tool is also created to account for the variability in the transition probabilities over the horizon.

Our results show how the core segment population evolves over the 20-year time horizon with Core Segment 1 population (with lowest morbidity scores) size decreasing slightly while the size of all other segments increasing. We also provide projections for different points of

delivery levels activity for all core segments. Ultimately, while the population is expected to increase by 14% over the 20-year horizon, the total cost is expected to increase by 41%. Using the simulation tool, we are also able to show confidence bands around the projections. Further, we consider mitigations to these 'business as usual' trajectories, to establish the impact of different resource constraints on core segment transitions and per capita costs.

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Assessing the impact of a novel risk assessment test on breast cancer clinic waiting times, costs, and health outcomes: a discrete event simulation model

Dr Alison Smith, Dr Paola Cocco, Dr Nisha Sharma, Professor Richard Neal, Louise Hick, Professor Bethany Shinkins

Parallel 4 - OR in Health and Social Care, Room 3.1, September 13, 2023, 09:00 - 10:30

Biography:
Paola works as a Research Fellow at Academic Unit of Health Economics (AUHE) at the University of Leeds. She mostly works on projects related to test evaluation, specifically projects related to new diagnostic and screening tests.

Paola had previously joined AUHE in 2018 as a Postgraduate Researcher in Health Economics. Her PhD project focused on integrating early economic modelling into the development

process of Target Product Profiles for diagnostic tests. Paola applied the early economic modelling to derive necessary performance requirements new rapid tests for Clostridium difficile infection should possess based on cost-effectiveness considerations. Paola developed a resource-constrained discrete event simulation models to capture the main activities and processes patients face while waiting for their diagnosis of CDI up to discharge.

Background: Breast cancer clinics across the UK are struggling to cope with high demand and growing workforce pressures. Novel risk prediction and triage tools – such as the PinPoint test – could help to reduce unnecessary clinic referrals and/or prioritise patients considered to be at highest risk.

Methods: A simulation model was built in SIMUL8 to reflect the annual flow of patients through a single UK centre (the Leeds Teaching Hospitals Trust (LTHT) breast cancer clinic). The model tracks individual patients from their initial GP presentation, through to clinic services (including initial assessment, mammogram, ultrasound and biopsy), accounting for available clinic resources (e.g. staff and clinic rooms). Patients exit the model with a final diagnosis of breast cancer (following a multi-disciplinary team [MDT] meeting) or no breast cancer. Model parameters were based on LTHT electronic health record and associated Leeds Patient Level Information and Costing System (PLICS) datasets for 2018/2019, as well as literature estimates and expert opinion. The analysis explores whether the PinPoint test could enable the LTHT clinic to suspend two weekend locum clinic services, which have been employed since early 2022 as a means of dealing with clinic demand. Two test use-cases are

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evaluated: PinPoint prioritisation (using the test to prioritise who gets seen first in the clinic), and PinPoint triage + prioritisation (additionally avoiding referrals in patients classified as low risk). Key outcomes evaluated included the proportion of patients meeting two-week wait (TWW) and 28-day referral targets, NHS diagnosis-related healthcare costs, and patient life years lost (LYL) as a result of referral delays.

Results: To be confirmed in July 2023

Towards More Nuanced Patient Management: Decomposing Readmission Risk with Survival Models

Dr James Todd[1], Prof Steven Stern[1]
[1]Bond University

Parallel 4 - OR in Health and Social Care, Room 3.1, September 13, 2023, 09:00 - 10:30

Biography:
Dr James Todd is an Assistant Professor of Data Analytics at Bond University. As part of the Centre for Data Analytics, his research focuses on the application of advanced statistical, machine learning, and deep learning techniques to translate large and varied data sources into insights supporting organisational decision-making. His PhD centred on the application of statistical and machine learning techniques to healthcare to improve readmission prediction. In recognition of the need for effective analytics to include stakeholders throughout the process, partnerships with industry have been a theme of past work. Notable examples of such projects have included those in the healthcare space, such as the application of machine learning techniques to improve patient management. This work has been published in prestigious journals such as Decision Support Systems and the International Journal of Medical Informatics.

Unplanned hospital readmissions are costly and associated with poorer patient outcomes. Overall readmission rates have also come to be used as performance metrics in reimbursement in healthcare policy, further motivating hospitals to identify and manage high-risk patients. Many models predicting readmission risk have been developed to facilitate the equitable measurement of readmission rates and to support hospital decision-makers in prioritising patients for interventions. However, these models consider the overall risk of readmission and are often restricted to a single time point. This work aims to develop the use of survival models to better support hospital decision-makers in managing readmission risk. First, semi-parametric statistical and nonparametric machine learning models are applied to adult patients admitted via the emergency department at Gold Coast University Hospital (n = 46,659) and Robina Hospital (n = 23,976) in Queensland, Australia. Overall model performance is assessed based on discrimination and calibration, as measured by time-dependent concordance and D-calibration. Second, a framework based on iterative hypothesis development and model fitting is proposed for decomposing readmission risk into persistent, patient-specific baselines and transient, care-related components using a sum of exponential hazards structure. Third, criteria for patient prioritisation based on the duration and magnitude of care-related risk components are developed. The extensibility of the framework and subsequent prioritisation criteria are considered for alternative populations, such as outpatient admissions and specific diagnosis groups, and different modelling techniques. Time-to-event models have rarely been applied

for readmission modelling but can provide a rich description of the evolution of readmission risk post-discharge and support more nuanced patient management decisions than simple classification models.

Cost-effectiveness requirements for implementing artificial intelligence technology in the UK breast cancer screening service

Dr Armando Vargas-Palacios[1], Dr Nisha Sharma[2], Dr Gurdeep Sagoo[3]
[1]Academic Unit of Health Economics, University Of Leeds, [2]Leeds Teaching Hospital NHS trust, [3]Newcastle University

Parallel 4 - OR in Health and Social Care, Room 3.1, September 13, 2023, 09:00 - 10:30

Biography:
Dr Vargas-Palacios, holds a PhD in Health Economics from the University of Sheffield. His research focuses on the economic evaluation of medical interventions, new technologies, treatment pathways, and medical devices. He is an expert on the use of simulation techniques (such as discrete event simulation) to evaluate system-wide implications of implementing a new technology or an alternative treatment pathway. He is part of the MedTech cooperative Leeds as an expert in Health Economics which supports the development of new technologies in the field of surgery aimed at improving health care provision and quality of life for patients.

Background
In the UK, the NHS National Breast Screening programme, aims to detect breast cancer early. The reference standard approach requires mammograms to be independently double-read by qualified radiology staff. If two readers disagree, arbitration by an independent reader is undertaken. Whilst this process maximises accuracy and minimises recall rates, the procedure is labour-intensive, adding pressure to a system currently facing a workforce crisis. Artificial intelligence (AI) technology has been suggested as a substitute for a human reader as a solution. While such technology has shown to be non-inferior in performance as a second reader, the minimum requirements needed for such technology to be a cost-effective alternative for use in the NHS, have not been evaluated.

Methods
We developed a discrete event simulation model to replicate the complexities of the NHS screening services, and the disease itself and to investigate the minimum/maximum requirements of the AI technology in terms of its effectiveness, set-up costs, maintenance, and maximum reimbursable price (MRP) for the technology to be cost-effective for the use in the NHS.

Results
Our results suggest that if the technology proves to be as effective as standard practice, then a price of up to £5.50 per scan plus a set-up cost of £35,000 would make this technology suitable for the NHS. Combinations of other variables such as increased

specificity, or locum levels may increase the MRP of the technology while maintaining cost-effectiveness.

Conclusion

An AI technology may be a cost-effective alternative when performing at similar levels to two human readers, providing a set of price points and set-up costs that allowed the programme to be equally costly or cheaper than standard practice. The latter indicates that AI has the potential to substitute a human reader to aid services struggling to recruit or meet demand.

Decision making factors of mHealth app adoption intention. The case of mental health apps.

Dr Korina Katsaliaki[1], Dr Panagiota Galetsi
[1]International Hellenic University

Parallel 5 - OR in Health and Social Care, Room 3.5, September 13, 2023, 10:50 - 12:20

Biography:
Korina Katsaliaki is an associate professor in Operations Management in Services at the School of Humanities, Social Sciences and Economics at the University Center of International Programmes of Studies of International Hellenic University (IHU). Before joining IHU, Korina was a lecturer at Middlesex University as well as a part-time lecturer at the University of Southampton. She gained an MSc in Management Sciences and a PhD from the University of Southampton.

Her research interests include health services research, business analytics and simulation modelling methodologies, the analysis and modelling of supply chains, the analysis and development of business games and bibliometric analysis in the above thematic areas. Dr Katsaliaki has published more than 60 papers in international scientific journals, conference proceedings and book contributions and has received funding for several national and international projects. Korina is an associate editor of the Journal of Simulation. She is also the Director of two MSc programmes and the Institutional Erasmus Coordinator at IHU.

Recent trends in healthcare systems have shifted toward eHealth (electronic healthcare) and mHealth (mobile healthcare). There is a rapid growth of mHealth applications including apps which identify symptoms and help individuals manage their mental health. In this study, we investigated the market of mHealth apps with a focus on mental health apps to explain the factors that affect patient/consumer behavior intention in using these apps based on their characteristics and attributes. By using several related keywords, such as “mental”, “stress”, “depression”, “anxiety”, “bipolar”, “optimism”, “mood” we identified and downloaded apps from Play store and App store which formulated a database of around 500 mental health apps. Based on the Technology Acceptance Model (TAM) we investigated the relationships among app adoption intention and app usefulness and ease of use. Furthermore, we expanded the TAM model by also adding and exploring the elements of app privacy, reliability and supported conditions that are crucial for user adoption of such health applications. Moreover, our survey took a special interest in those apps that utilize smart technologies, such as artificial intelligence (AI) and their characteristics in relation to the level of user adoption. To investigate the relationships between app intention of use and the selected variables of the expanded TAM we used multiple linear regression statistical analysis. The results provide interesting findings with regard to the relationships

among user rating and downloads and user usefulness, ease of use and trust. This study contributes to the literature of information systems, operational research and health applications/services in providing a better understanding of the certain characteristics of mobile apps that attract patients/consumers and how certain app functionalities affect user decision process. (Research dissemination is co-financed by Greece and E.U. project "Support for Internationalization Actions", MIS 5154651).

Fair and Effective Vaccine Allocation During a Pandemic

Dr Eda Yucel, Prof Sibel Salman, Ms Parinaz Kiavash, Prof Gunes Erdogan
[1]University of Bath

Parallel 5 - OR in Health and Social Care, Room 3.5, September 13, 2023, 10:50 - 12:20

Biography:
Güneş Erdoğan is a Professor of Operations Research at the University of Bath, School of Management. His research is focused on the applications of combinatorial optimization in logistics and healthcare. After receiving his PhD in Industrial Engineering from Bilkent University (2007), Güneş has held permanent faculty positions at Ozyegin University, Istanbul (as founding faculty), University of Southampton, and University of Bath. In 2010, he received the Kuhn Award from the journal Naval Research Logistics for a paper he co-authored, entitled "Ambulance Location for Maximum Survival". He has been an Area Editor for the journal Computers & Operations Research since 2019. He is a member of the Bath Centre for Healthcare Innovation & Improvement (Chi2, www.bath.ac.uk/chi2) and the EURO Working Group on Vehicle Routing and Logistics Optimization.

In this study, we focus on the Vaccine Allocation Problem (VAP). Given a set of locations with initial populations of susceptible, vaccinated, and infected individuals, hospital capacity, and infection parameters, the VAP aims to determine the production and allocation decisions for the vaccine among the locations within a fixed planning horizon subject to production capacity, with the objective of minimizing total mortality. The spread of the pandemic is modeled using the well-known epidemiological model of Susceptible-Infected-Recovered (SIR) and integrated into the vaccine production and allocation decisions. A MINLP formulation is presented and solved to optimality using Gurobi. Computational results provide insights about the relative importance of hospital capacity, vaccine availability, and disease spread parameters in a pandemic.

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Developing innovative, advanced analytical tools to help improve NHS Talking Therapies demand and capacity planning.

Miss Elizabeth Yardley[1,2], Dr Alice Davis[2], Prof Christos Vasilakis[1]
[1]University Of Bath, [2]Mayden

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Elizabeth (Lizzie) Yardley is a Knowledge Transfer Partnership (KTP) Associate working on a collaborative project between the University of Bath and Mayden about the analysis of care pathways. Mayden is a Bath-based healthcare software development company that provides patient management solutions to the NHS and other providers of the NHS Talking Therapies programme.

It is estimated that one in six adults in England have a mental health disorder and would benefit from a course of psychological therapy. The NHS Talking Therapies Programme (formerly IAPT: Improving Access to Psychological Therapy Services) was established in 2008 and now treats over a million patients with common mental health problems each year. This evidence-based programme is based on the principle of stepped care, where effective but less resource intensive treatments are delivered to patients first and higher intensity interventions are then provided if required.

In order to meet NHS targets, the programme needs to increase access rates by 50% by 2023/24, while meeting service standards for waiting times and recovery rates. Service providers are therefore looking at opportunities to increase capacity and productivity. Characteristics of service delivery have been demonstrated to be associated with patient outcomes and therefore access to tools that enable providers to have a holistic view of the delivery and usage of their services are central to the improvement of the operational and clinical performance of the programme.

The aim of this project is to develop innovative, advanced, analytical tools to help improve understanding and management of NHS Talking Therapies service demand and capacity. The project will summarise and model patient flow in NHS Talking Therapies care pathways and investigate how the use of the care pathway impacts patient outcomes. The major impacts of this project are expected to be improved access to services, improved utilisation of resources, resulting in reduced waiting times, better recovery rates and reduced patient drop out.

This research project is organised as a Knowledge Transfer Partnership (KTP) between the University of Bath and Mayden. Mayden is a software development company providing

patient management solutions to the NHS and other providers of the Talking Therapies programme. Mayden's main product is iaptus; the leading digital care record for psychological therapy services. This study will analyse anonymised data from iaptus to investigate and model patient flows through care pathways using process mining and other data-driven methods, augmented by simulation modelling and a comprehensive programme of engaging with end-users.

Modelling decisions in Home Health Care at multiple planning levels

Dr Luca Grieco[1], Professor Martin Utley, Professor Sonya Crowe
[1]University College London

Parallel 5 - OR in Health and Social Care, Room 3.5, September 13, 2023, 10:50 - 12:20

Biography:
Luca has a background in Industrial Engineering and Operational Research techniques gained during his Bachelor's and Master's degrees at Sapienza University of Rome. In 2008 he moved to France where he earned his PhD in Genomics and Bioinformatics dealing with machine learning and dynamical modelling approaches to identify targets for cancer therapy. In 2014 he joined CORU where he applies quantitative methods to support health protection policy and to improve performance in healthcare systems.

Efficient deployment of resources to deliver home-based care is critical for the sustainability of health care systems, particularly given the trend towards ageing populations with more complex needs. Recent literature reviews of OR applied to Home Health Care reported an abundance of work focusing on operational decisions and less work at strategic and tactical levels, with little explicit recognition of the hierarchical nature of these decisions which undermines the potential of OR approaches to support real-life decisions.
We developed a modelling framework, consisting of a synthetic data generator and an optimisation environment, to enable coherent analysis of Home Health Care decisions made at different planning levels in a given hierarchical order and affecting each other.
We tested our approach on case studies built upon challenges currently faced by an organisation serving two boroughs in London. We selected decision hierarchies of interest and formulated the corresponding optimisation models, which we implemented according to our modelling framework. We built reference synthetic datasets using parameters estimated from data gathered from the two boroughs.
We will illustrate the potential benefits and challenges of informing decisions at higher planning levels while accounting for their effects at lower planning levels and vice versa, in particular depending on whether the aims of those decisions are aligned or in conflict with each other.

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Usage over time of the Coronavirus in the UK dashboard

Mr Nathan Hook[1]
[1]UKHSA

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Nathan Hook is a senior public health intelligence analyst for UKHSA. His academic background in Psychology, and he continues to publish research and operate a private therapy practice alongside his civil service career.

The coronavirus dashboard was created early in the pandemic to make information on cases, deaths, healthcare, testing and vaccination available to the wider public. This poster presents usage statistics over time. Findings include the peak usage day changing from Wednesday in 2022 to Thursday in 2023, and a strong correlation between case data and usage requests. In June 2023, users focus on deaths and hospitalisations data, rather than testing or vaccinations. Most webpage visitors are from England, used mobile devices, and Singapore had the most active users after the UK.

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Exploring the Circular Economy of Surgical Medical Devices: Environmental and Health related impact: A New Approach using Discrete Event Simulation

Dr Ramzi Fayad[1], Mr Mohd Shoaib, Dr Antuela Tako, Dr Armando Vargas-Palacios[1]
[1]University Of Leeds

Parallel 6 - OR in Health and Social Care, Room 4.16, September 13, 2023, 16:00 - 17:00

Biography:

I have Joined the University of Leeds in January 2023 as a research fellow in circular economy of small medical devices at the University of Leeds.

I have more than 10 years of experience in commercial and academic fields. I am passionate about implementing data driven solution to solve lean production/management problems across various business sectors. I am expert in coordinating and improvement all aspects of human and non-human business systems/processes through analytical modelling and simulation techniques

I have earned my PhD in Manufacturing Engineering and Operations Management from the Nottingham University. I have worked as Quality Engineer for Rolls Royce 2000 to 2006 and University Lecturer from 2007 till 2020.

Research interests

My research interest ranges from: circular economy, system optimisation, Machine Condition Monitoring, Vibration Monitoring, Oil Analysis. And Operations Research.

Qualifications

PhD Manufacturing Engineering and Operations Management

MSc Computer Engineering

BSc Computer Engineering

The circular economy of surgical medical devices in the NHS emphasises its capacity to achieve cost effectiveness while delivering substantial environmental and economic

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advantages. However, limited empirical research has been conducted due to associated high costs, resource requirements and impact on patient care and health care provision.
This research proposes a novel modelling technique that integrates the complexities of the NHS procurements, supply chain, medical procedures, health care provision and patient benefits of implementing a circular system for medical tools.
It investigates the impact of the circular economy on social-ecological resilience, delves into possible trade-offs, and underlines the variation in the NHS behaviour required for a circular process while providing cost-effective treatment alternatives.
The findings of this research provide valuable suggestions to assist firms, governments, health care practitioners and educators in the development and implementation of circular economy policies that enhance resilience within the NHS and beyond.

Estimating the local demand for General Practice (GP) resources in England

Dr Colin Stewart[1]
[1]More Metrics Ltd

Parallel 6 - OR in Health and Social Care, Room 4.16, September 13, 2023, 16:00 - 17:00

Biography:

For over 40 years Colin's career has been built around using analytics to solve business problems. After a career in scientific research, Colin switched industries in the 1980s, when he joined the NatWest OR Group. At NatWest, Colin ran teams across different functions in the retail bank spanning OR, Corporate Banking, Finance, Marketing and Analytics.

Working independently since 2010 Colin has developed new ways of using open source data and spatial analysis techniques that underpin More Metrics data and models. Recent developments he has led include the development of synthetic populations for the UK that are now being deployed in a wide-range of applications for a growing list of clients.

In July 2022, forty-two Integrated care systems (ICSs) in England were formed.

Integrated care partnerships (ICPs), within each ICS, are tasked with addressing resource allocation issues holistically. Their remit includes the optimal resourcing of GP practices within their catchment area. This is a critical part of their work, as it is the first point of contact for most patients to gain access to the full range of NHS services.

To support the work of ICPs we have reviewed the range of data that is open to the public relating to GP practices, and have analysed this data to evaluate the options for allocating GP surgery resources to best meet the aggregate health needs of local communities. The presentation will describe this research and the results obtained to date.

This analysis is an on-going, pro-bono research project that is informed by our commercial work at More Metrics estimating disease prevalence and incidence at neighbourhood (output area) level across the UK. Our neighbourhood disease prevalence datasets are currently being used to good effect by a leading health charity.

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Modelling risk-factors for non-communicable diseases

Dr Steffen Bayer[1]
[1]University of Southampton, Southampton Business School and CORMSIS

Parallel 8 - OR in Health and Social Care, Room 3.15, September 14, 2023, 09:00 - 10:30

Biography:

Dr. Steffen Bayer is a Lecturer in Business Analytics at Southampton Business School and a member of CORMSIS. Most of his work focuses on health and social care research. He has conducted qualitative research on implementing home-based technology-supported health delivery and home dialysis. He is interested in how analytical methods and, in particular, simulation modelling can support the planning and implementation of health and care services, such as telecare, stroke care (including risk factors and secondary prevention) or cancer screening. Before joining Southampton Business School, he has worked at Duke NUS Medical School in Singapore, Imperial College London, and the University of Sussex.

Non-Communicable Diseases (NCDs) are the leading public health challenge globally, with disproportionately higher rates in developing countries due to unhealthy diets, physical inactivity, tobacco use, and harmful use of alcohol; systemic, and structural factors include weak and non-performing health systems as well as problems such as air pollution. Programmatic inefficiencies and operational failures of both the health and food systems also contribute to the rising burden of NCDs. In addition, population ageing acts in tandem as older individuals have an increased risk of NCDs.
This presentation will introduce a hybrid modelling approach to simulating the effect of risk factor management on (primary and secondary) prevention of cardio-vascular diseases and diabetes. The model allows to compare the effect of public health interventions on long-term health status of the population and can support health policy making.

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Resource Planning for Meeting Capacity and Demand Requirements in Multiple Specialties: Optimising Patient Access and Reducing Waiting List Length

Miss Elizabeth Williams[1]
[1]Cardiff University

Parallel 8 - OR in Health and Social Care, Room 3.15, September 14, 2023, 09:00 - 10:30

Biography:
Elizabeth Williams is a Research Associate in Operational Research holding a joint position at the School of Mathematics, Cardiff University and the Cardiff and Vale University Health Board. Her PhD thesis and research interests are in mathematical programming, optimisation and machine learning, applied to healthcare operations.

The number of patients currently waiting for NHS outpatient appointments has increased due to staffing challenges, increasing demands and the prolonged effects of the disruptions caused by the COVID-19 pandemic. The Welsh Minister for Health has established national referral to treatment targets aimed at reducing the waiting time for patients at various stages, including outpatient, inpatient, day case, therapy, and diagnostic services. The accumulation of patients exceeding the target waiting time is referred to as the Backlog, which varies across specialties and services.

In collaboration with a local health board, a dataset containing the number of patients waiting at the end of each month for an appointment, and their current waiting time in terms of weeks has been used with forecasting techniques to determine the expected future demand across these services. This work has been further developed by utilising a queueing theory approach utilising the Python package, Ciw. By incorporating these new patient arrival rates along with current service times, and the number of available resources, the queueing model can estimate key performance indicators such as expected waiting times, queue lengths, and resource utilisation. This quantitative approach enables healthcare organisations to gain insights into the optimal allocation of resources necessary to meet the Welsh Government's targets and reduce the patient backlog.

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Orthopaedic Care Pathway Modelling Using Hybrid Simulation

Mr. Matthew Howells[1], Professor Paul Harper[1], Daniel Gartner[1], Doctor Geraint Palmer[1]
[1]Cardiff University

Parallel 8 - OR in Health and Social Care, Room 3.15, September 14, 2023, 09:00 - 10:30

Biography:
Matthew Howells is a PhD in Operational Research at Cardiff University. Currently, his research applies simulation techniques to model patient flow in the Trauma & Orthopaedic pathway at Cardiff & Vale University Health Board.

Disruptions caused by COVID-19 still cause backlogs in many countries' elective patients waiting lists. In this research, we focus on Orthopaedics, which is a specialty that faces extraordinary pressures driven not just by current elective care backlogs, but also the phenomenon of an ageing population. We present the results of a systematic literature review into operational research methods applied to orthopaedic settings and treatments. Our analysis of 492 papers reveals that there is limited modelling of holistic care pathways, few applications of mixed-methodologies, and the potential need for increased resource and capacity planning. Having identified gaps in the literature, we are developing a hybrid simulation model that combines the paradigms of discrete-event simulation (DES) and system dynamics. The DES component models patient flows through a holistic orthopaedic surgical pathway. This interacts with a system dynamics component, which considers the musculoskeletal health of the general population and how this affects Secondary Care demand through referrals from Primary Care and emergency demand. Our model will enable hospital staff to make more informed decisions on demand and capacity planning, to help find strategies to alleviate the treatment backlog and improve care outcomes.

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Predicting emergency admissions to hospital specialties using real-time data from Electronic Health Records: A Machine Learning application in operational use

Dr Zella King[1], Craig Wood[2], Professor Sonya Crowe[1], Mr Joe Farrington[1], Dr Jonathan Gillham[2], Thomas Keen[1], Dr Ken Li[1], Nel Swanepoel[1], Dr Steve Harris[2], Professor Martin Utley[1]

[1]University College London, [2]University College London Hospitals NHS Foundation Trust

Parallel 9 - OR in Health and Social Care, Room 3.15, September 14, 2023, 11:00 - 12:30

Biography:

Zella King is a Research Associate at UCL and an honorary consultant at University College London Hospital. With a team from UCL and UCLH, she built a real-time application to predict demand for emergency beds using data from the hospital's EHR. This work has been published in Nature Digital Medicine. She has a PhD from Birkbeck College London in Occupational Psychology, and a MSc in Health Data Science from UCL.

Background: UK hospitals operate at capacity for much of the time. Bed planners have the difficult job of ensuring enough emergency beds are available within each clinical specialty, to avoid admission delays and outlying patients. In previous work, published in Nature Digital Medicine, we created an analytical pipeline to predict aggregate numbers of emergency admissions in the next 8 hours. However, like many applications of AI in healthcare, this did not cover the 'last mile' into daily use. To be truly useful to bed planners, it needed to predict by medical specialty, so that they could target activity to free up beds.

Aim: We aimed to develop an application that would enable bed planners to predict how many admissions each clinical specialty should plan for, and to provide it in a format they could use instantly within their daily workflows. They wanted predictions five times a day, to coincide with routine 'huddles' to manage hospital capacity.

Methods: Using data on 145,364 patients who made 197,774 visits to the ED between 19 August 2021 and 19 February 2023, we trained a XGBoost classifier to predict, in real-time, each patient's probability of admission from the Emergency Department (ED). Separately, we used data on sequences of specialty consultation requests to estimate the conditional probability of each patient, if admitted, being admitted to a given specialty. These were combined into aggregate predictions of demand for beds by specialty, incorporating patients yet to arrive who would – if the ED was meeting its aspirational targets – be admitted in the next 8 hours.

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Results: On a test set of 41,227 visits covering four months to 19 Feb 2023 the predicted probability distributions by specialty were in line with observed values. An application that runs five times daily, emailing predictions to bed planners, is now in daily use.

Conclusion: By designing the model for operational use at the outset, our application was able to cover the 'last mile' into deployment. We discuss the aspects of operational use that Machine Learning researchers need to consider if they wish to see models applied in healthcare operations in practice.

Dependence between patient arrivals and service times in emergency department data

Dr Laura Boyle[1]
[1]Queen's University Belfast

Parallel 9 - OR in Health and Social Care, Room 3.15, September 14, 2023, 11:00 - 12:30

Biography:

Dr Laura Boyle is a Lecturer in Data Analytics at the Mathematical Sciences Research Centre, Queen's University Belfast. Prior to this she worked as a Research Fellow of the Australian Research Council Centre of Excellence for Mathematical and Statistical Frontiers at the University of Adelaide. Her research interests are in simulation modelling and data anlaytics with applications in healthcare. Laura is the current chair of the OR Society Early Career Researcher's Network.

Hospital emergency departments are frequently modelled components of healthcare systems, owing to their importance in primary healthcare access and to their scrutiny in politics and the media. Queueing models are routinely used to model emergency departments and it is commonly assumed that service time distributions are independent of system state. This talk will explore a motivating emergency department dataset to discuss the dependence between patient arrivals and service times. A method for detecting the source of the dependence will be presented and the implications for developing accurate queuing models of hospital systems will be discussed.

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Near real-time prediction of hospital performance metrics using scalable random forest algorithm

Dr Nick Howlett[1], Dr Richard Wood[1]
[1]National Health Service

Parallel 9 - OR in Health and Social Care, Room 3.15, September 14, 2023, 11:00 - 12:30

Biography:

Nick Howlett is a Senior Data Scientist working within the UK's National Health Service (NHS) in the Bristol, North Somerset and South Gloucestershire (BNSSG) Integrated Care Board. His background is in physics, mathematical modelling, and data science.

While previous studies have shown the potential value of predictive modelling for emergency care, few models have been practically implemented for producing near real-time predictions across various demand, utilisation and performance metrics. In this study, 33 independent Random Forest (RF) algorithms were developed to forecast 11 urgent care metrics over a 24-hour period across three hospital sites in a major healthcare system in and around Bristol, England. Metrics included: ambulance handover delay; emergency department occupancy; and patients awaiting admission. Mean Absolute Error (MAE), Root Mean Squared Error (RMSE) and Symmetric Mean Absolute Percentage Error (SMAPE) were used to assess the performance of RF and compare it to two alternative models: naïve baseline (NB) and Auto-Regressive Integrated Moving Average (ARIMA). Using these measures, RF outperformed NB and ARIMA in 76% (N = 25/33) of urgent care metrics according to SMAPE, 88% (N = 29/33) according to MAE and 91% (N = 30/33) according to RMSE. The RFs developed in this study have been implemented within the local healthcare system, providing predictions on an hourly basis that can be accessed 24/7 by local healthcare planners and managers. Further application of the models by another healthcare system in South West England demonstrate the wider scalability of the approach.

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Exploring the likely impact of health service innovations in outpatient clinics for patients with long-term conditions

Dr. Gozdem Dural Selcuk[1], Prof Christos Vasilakis[2], Dr. Baris Yalabik[2]
[1]Social Sciences University of Ankara, [2]University of Bath

Parallel 10 - OR in Health and Social Care, Room 3.15, September 14, 2023, 14:30 - 16:00

Biography:

Dr.Gozdem Dural Selcuk has been working as an assistant professor in the Department of Business Administration at Social Sciences University of Ankara (SSUA) since 2022. She received her Ph.D. in Management from Hacettepe University (2015). She has an MBA degree from Bilkent University (2010) and holds a B.Sc. in Industrial Engineering from Middle East Technical University (METU) (2007). Before she joined SSUA, she worked as an assistant professor in the Department of Industrial Engineering at Atılım Unversity (2019-2022). She also worked as a post-doctoral research associate at University of Bath, School of Management in 2016, as a research assistant at Hacettepe University (2015-19) and Middle East Technical University (2011-15). Her recent research interests have been focused on operations research methodologies applied in healthcare services, healthcare policies and evaluation of their sustainability and effectiveness.

The clinical management of patients with long-term conditions involves periodical visits to health and care services. Typically, the length of the interval for the next follow-up appointment is discussed with the patient at the end of each appointment, with a specific date confirmed by hospital administrators at a later stage. Thus, the typical set of appointments of a hospital clinic is made up by new referrals, and follow-up appointments of different intervals. A small proportion of patients may be discharged or referred on to a different service, however the majority of patients will continue to been seen in the clinic for a number of years. Against a backdrop of population ageing and people living longer with more than one long-term condition, coupled by workforce shortages, it is not surprising that many clinics and care systems are under pressure to come up with innovative ways of dealing with continuous increases in demand.

A number of service innovations have been designed and implemented to deal with this particular problem. For example, in remote-review clinics specially trained technicians and other allied health professionals carry out a number of tests, with a clinician evaluating the results and making clinical decisions, remotely and asynchronously. In the “Patient Initiated Follow-Up (PIFU)” stable patients with long-term conditions may be given an appointment further in to the future and instructions to contact with the clinic should their symptoms

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worsen. The aim is to empower patients to get the control of their health condition while reducing the overall number of appointments needed in clinic.

In this study, we adopt a systems thinking lens to examine the role of such health service innovations in outpatient care. Using Systems Dynamics models, we explore a number of trade-offs inherent in these innovations and the conditions under which they can operate in an efficient manner.

Discrete Event Simulation for Perishable Inventory Management; a case study of Human Milk Banking

Mrs Marta Staff[1], Professor Navonil Mustafee[1]
[1]University Of Exeter, Business School

Parallel 10 - OR in Health and Social Care, Room 3.15, September 14, 2023, 14:30 - 16:00

Biography:

Marta Staff, a recipient of an ESRC scholarship, is a PhD candidate at the University of Exeter, Business School. Her research focuses on utilising OR techniques to enhance decision making in supply chains and operations management, with a specific emphasis on perishable goods. Currently, she explores inventory management in healthcare through a case study of human milk banking in the UK.

Perishable inventory management is crucial in industries such as food, floral, pharmaceuticals, and healthcare, where products have limited shelf life. While the traditional newsvendor model has been widely used for optimising inventory decisions over a single period, it may not capture the complexities of products with longer shelf life. Additional complexity in some systems can be attributed to the heterogeneity of product shelf life within a batch. To study this aspect, which is widely unaddressed in the literature, we propose a Discrete Event Simulation (DES). Our model is built using a case study of inventory management of incoming batches of donor human milk to a human milk bank. The DES model allows us to simulate various scenarios and evaluate the impact of different factors on inventory management and system performance. These factors include batch characteristics, processing times, storage conditions, and demand variability. By capturing the dynamic nature of the system, the DES model provides insights into the effectiveness of inventory control policies, and strategies towards minimising waste, maximising product availability, and ensuring timely delivery.
Beyond discussing in more detail the technical intricacies related to perishability, especially the shelf life heterogeneity of the case study, a comprehensive overview of our model will be given. Moreover, preliminary results based on empirical data from Hearts Milk Bank will be presented.

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Multi-objective optimisation for blood matching in transfusion dependent sickle cell patients

Dr Folarin Oyebolu[1], Merel Wemelsfelder[2], Prof Simon Stanworth[3], Dr William Astle[1]
[1]University of Cambridge, [2]Sanquin Research, [3]University of Oxford

Parallel 10 - OR in Health and Social Care, Room 3.15, September 14, 2023, 14:30 - 16:00

Biography:

Folarin is a Research Associate in Operational Research working at the MRC Biostatistics Unit at the University of Cambridge on an interdisciplinary project called Haem-Match. Haem-Match aims to provide blood for transfusion that is more precisely matched to patients' blood groups, and optimally allocate units of blood in order to maintain blood stocks and minimise the risk of adverse reaction events.

Blood transfusions are a life-saving treatment in people with sickle cell disorders and major thalassaemia. Blood group matching for blood transfusion is currently based on algorithms that consider a range of factors such as blood type, testing for antibodies to blood group antigens and availability of blood, but these processes are resource intensive.
We are undertaking a programme of research to define alternative approaches to matching, and to consider different strategies for assigning blood. This will involve using extended blood type information from the NHS' planned introduction of a new genetic blood type/antigen test for patients and donors.
Previously, we formulated a Hitchcock transportation problem in order to allocate extensively typed donor RBC units to extensively typed SCD patients. This was done by assigning penalties to each pair of RBC unit and patient request based on the age of the unit and antigens on both RBC unit and patient. By simulating and solving a series of these problems, we were able to demonstrate that extended antigen matching reduces the incidence of alloimmunisations.
We extend this by using Bayesian optimisation to tune weights of the penalties in order to further reduce the incidence of alloimmunisation. We show that optimised penalty weights can reduce alloimmunisation more than equal weights. We also optimise the weights to minimise multiple objectives (alloimmunisation, shortages, and wastage) and estimate the Pareto front.

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Project & Risk Management

Improving the performance of manufacturing supply chains in Industry 5.0: An analysis using fuzzy-TOPSIS approach

Ms Jingyang Yan[1], Dr. Nicholas Dacre[1], Dr M.K.S. Al-mhdawi[2], Dr Hao Dong[1], Dr Regina Frei[3]
[1]University Of Southampton, [2]Teesside University, [3]University Of Surrey

Parallel 2 - Project & Risk Management, Room 3.15, September 12, 2023, 13:15 - 14:45

Biography:
Jingyang Yan is a PhD student at Southampton Business School, the University of Southampton. She holds an MSc degree in Supply Chain Management and Logistics from the University of Southampton. Her current research interests include Industry 5.0, sustainable supply chain, sustainability and multi-criteria decision-making (MCDM).

As the latest industrial revolution, Industry 5.0 has the potential to profoundly reshape the design and management of supply chains in multiple ways, such as to make the supply chain more human-focus, sustainable, and flexible. This offers opportunities for organisations to promote their business competitiveness. While the adoption of Industry 5.0 is gaining momentum in the manufacturing sector, there exists a risk of failure and being locked into ineffective strategies during the transition. Despite this pressing need, research on Industry 5.0 remains in early stage. Particularly, there is a lack of adequate discussion on how to evaluate manufacturing supply chain performance in the context of Industry 5.0. This paper aims to enhance supply chain performance by identifying a comprehensive list of performance indicators and prioritising potential solutions and alternatives based on their levels of significance. A multistep research methodology was adopted in this study, including (1) using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) method to identify a comprehensive list of key performance indicators and alternative solutions to improve manufacturing supply chain performance in Industry 5.0; (2) collecting survey data from the industry professionals to quantify the level of significance of the identified alternatives; and (3) applying the fuzzy Technique for Order of Preference by Similarity to Ideal Solution (TOPSIS) to prioritise the identified alternatives. The study identified a total of 28 indicators and four potential alternatives for improving manufacturing supply chain performance in Industry 5.0. The findings reveal that the implementation of a real-time operational framework, the promotion of transparency and information sharing among supply chain partners, and the leveraging of advanced technologies are the most significant alternatives in this regard. This paper contributes to the existing body of knowledge by providing a foundational foothold for researchers and

industry practitioners to make informed strategic decisions pertaining evaluation of and improvement in supply chain performance, further enhancing companies' competitiveness, profitability, and sustainability in the era of Industry 5.0.

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TRUST IN AI SYSTEMS FOR PROJECT AND RISK MANAGEMENT: EVALUATING THE ROLE OF TRANSPARENCY, REPUTATION, TECHNICAL COMPETENCE, AND RELIABILITY

Dr. Ming-wei Hsu[1], Dr. Nicholas Dacre[1], Dr. PK Senyo[1]
[1]Southampton Business School, University Of Southampton

Parallel 2 - Project & Risk Management, Room 3.15, September 12, 2023, 13:15 - 14:45

Biography:
Ming-Wei Hsu is a research associate at the Southampton Business School. He is currently working as part of the Innovate UK KTP project. His research interests focus on the application of machine learning techniques.

Machine learning algorithms are often considered black boxes due to their complexity which can reduce users' trust in AI systems. Explainable AI (XAI) is an emerging field aiming to improve transparency providing reasonable explanations for algorithmic predictions. In addition, presenting predictions from multiple AI systems can improve overall reliability. This study proposes a hybrid project prediction system that combines XAI for enhanced transparency and multiple machine learning algorithms for increased reliability, bridging the gap between decision-making and trust for project professionals and decision-makers by developing a theoretical model based on the literature of technology adoption, inter-organisation relationships, and XAI. The model assesses four trust factors: transparency, reputation, technical competence, and reliability.
In the context of project and risk management, transparency in AI systems can play a vital role in influencing decision-makers' confidence in predictions. Additionally, the reputation of AI systems or their developers can have a significant impact on the trustworthiness of the systems. Therefore, by incorporating technical competence and reliability into the model, this research aims to provide a comprehensive understanding of the factors affecting trust in AI systems for project and risk management applications. In order to examine the effects of these critical factors on users' trust, a survey experiment is employed, in which respondents access a prototype system and answer questions regarding their levels of perceived trust within the system. The analysis is conducted using structural equation modelling to understand emergent and actual relationships.
The findings will contribute to the AI and project management literature and practice by explicating the impact of factors, on the trustworthiness of AI systems. Therefore, by investigating this interplay the findings will foster a deeper understanding of the role of transparency, reputation, technical competence, and reliability in promoting trust, and ultimately, the implementation of AI systems in project and risk management.

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Systemic Risk Assessment and Management – addressing the implementation issue

Dr Colin Eden
[1]Strathclyde Business School

Parallel 2 - Project & Risk Management, Room 3.15, September 12, 2023, 13:15 - 14:45

Biography:
Before retiring was Professor of Management Science and Strategic Management at Strathclyde Business School. Has published 12 books and over 200 papers in OR and Management Journals. Is a Fellow of the British Academy of Management and previous Dean of Fellows. Has awards from the ORSociety, INFORMS and the Academy of Management.

If risk mitigation is to be successful then it is crucial to not only involve experts but also 'power-brokers' – those with the power to act. A good assessment of the risks and analysis of the risk system is of no use if risk mitigation does not follow.
Because of time and location constraints, 'fast and furious' risk assessment (construction of the risk system) and development of effective strategies is crucial to ownership and so implementation. The ability to construct the risk system quickly and directly with the group (whether they be together in the same location or located in their workplace/home) increases the speed of working. Similarly, the ability to visualise the risk system as a causal map speeds up an appreciation of the nature of the risky situation. Visualisation makes developing strategies that appreciate the systemic nature of the risky situation easier and faster.
This presentation reports on the use of a system and method of systemic risk assessment and the development of mitigation strategies that addresses the 'fast and furious' challenge. It is a system and method now used to address systemic project risks. It is/has been used successfully in Norway, Sweden and Spain during the recent Covid pandemic, for the preparations for the next pandemic, and addressing crisis management. Examples from these projects will be used to illustrate the system and method. The system and method uses a new internet based platform that allows participants to construct the risks system and develop strategies from different locations and with speed. In the case examples the mix of power-brokers and experts (typically 15-20 participants) devoted 10-12hrs in 3-4 workshops to develop mitigation strategies that were implemented and regarded as successful. In some instances the proposed strategies were validated using the risk model as the basis for simulation modelling.

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Soft OR & Problem Structuring Methods

Addressing the 'Right' Problem?

Dr Colin Eden[1], Professor Fran Ackermann[2]
[1]Strathclyde Business School, [2]Curtin University

Parallel 1 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 09:15 - 10:45

Biography:
Colin Eden has been Director of the Graduate School of Business at Strathclyde University and Head of the Department of Management Science. He has received awards from the OR Society, INFORMS, the British Academy of Management and Academy of Management.

We all know that If the initial problem structure is wrong then the solution will be wrong. Enabling a team of problem owners to define the problem, before operational researchers delve into detailed modelling of the problem or provide analytical validation of negotiated proposed solutions, is therefore a critical part of the operational research process.
Over the past few decades soft-OR problem structuring methods have proven their worth. However, they do suffer from two important significant weaknesses: i) they can demand serious amounts of time from busy managers who are often located in different offices, sometimes around the world; ii) they are bereft of analytical procedures that can provide significant support to aid the validation of the problem structure, Thus, method development needs to reduce the time commitment of problem-owners and also provide better initial analytical support. The method and tool assures co-creation of models and so higher levels of commitment.
The experience of the recent pandemic has introduced most managers to deliberating using an internet based conferencing system (eg Teams, Zoom etc). In line with this development a new problem structuring tool has been developed in such a way that it reflects the successful application of a well-established problem structuring method (SODA and causal mapping). In addition, it has enabled the enhancement of powerful analysis routines that can be used in real-time to support a team.
The tool and method has been used extensively in Norway, Sweden, Austria, Switzerland, UK and Australia. Typically the range of complex problems addressed include: multi-organisational collaboration, systemic risk management (including developing strategies for managing the next pandemic), understanding and exploiting competitive advantage, strategy development, brief (2hr) team solution finding as well as traditional problem

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structuring prior to detailed simulation modelling. In most of these uses the participants (problem-owners as well as 'experts') and facilitator have engaged from their own locations. The presentation will focus specifically on the new benefits, features, and advantages of such a system to both managers and analysts.

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Supporting Strategic Options Development and Analysis (SODA) through text mining when using media data

Dr Leila Abuabara[1], Professor Alberto Paucar-Caceres, Katarzyna Werner-Masters
[1]Unifesp

Parallel 1 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 09:15 - 10:45

Biography:
I am a PhD candidate in the Pos-graduation Programme in Operational Research at UNIFESP (Universidade Federal de São Paulo) and ITA (Instituto Tecnológico de Aeronáutica) in São Paulo/Brazil. I hold a master's degree in the same programme.

My research interests mostly lie in the areas of Soft OR, Problem Structuring Methods, Systems Thinking, Decision Analysis and multimethodologies, in particular in the combination of causal mapping and Strategic Options Development and Analysis (SODA) in practical applications focusing on real and social situations. Some published research includes the areas of educational policies, food planning during pandemic, organizational strategies, circular economy, and systems thinking development for OR practitioners.

Strategic Options Development and Analysis (SODA) is a well-established Soft Operational Research methodology for designing problem solving interventions. SODA uses causal (cognitive) mapping to visually capture and structure participants' perceptions. It is a powerful methodology when exploring perceptions in a medium sized group with primary data being gathered in a face-to-face intervention. This research features the use of secondary data as the source of SODA application when vast amounts of data in the form of media data (i.e., blogs, reports, televised interviews) are available for modelling perceptions. We propose to enhance SODA capabilities by taking advantage of analytics tools to support the use of causal mapping in analyzing a large volume of information. We introduce a conceptual multimethodological framework which combines causal mapping with visual text data mining. As language is the common currency for both approaches, although it is interpreted in different ways through lenses of each methodological perspective, we discuss how they can complement and counterpoint each other. We evaluate the framework and verify its benefits for an existent case of the railway's development project in Brazil which is originally an exclusive SODA case. We propose guidance to test framework's validity and reliability. Our findings confirm that the enhanced methodology is reliable and can be applied to a wide spectrum of similar cases when large volume of secondary data is available; this will facilitate the results of SODA analysis stage.

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Listening as modelling: Using Rich Notes for problem structuring in small groups

Mr Karthik Suresh[1]
[1]University Of Hull

Parallel 1 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 09:15 - 10:45

Biography:
Karthik Suresh is a Management Consultant who helps customers with energy, strategy, sustainability and analytics projects. His experience includes working with large and small organisations to select and implement strategic decision systems, improve and develop management and marketing capability and deploy risk management, IT, innovation and information systems projects.

Practitioners using problem structuring methods (PSMs) help participants in groups make sense of a situation they consider to be problematic and find consensus positions that enable action to be taken to improve the situation. Many approaches encourage participants to co-create models by picking up pens or markers and getting involved. Less attention is paid to how participants or practitioners listen to different perspectives, integrate different points of view and document findings. Listening is more than a single ability and can be conceptualised in different ways such as listening as information processing, listening as comprehension, and listening as retention, among others. This paper explores the concept of "listening as modelling" using Rich Notes, a novel approach to note taking and diagramming during meetings that uses a non-linear, non-hierarchical, unconstrained and distributed layout that documents what participants say, recognises interdependencies and generates options for action. Rich Notes has been developed within an action research programme consisting of over 300 real-world participant interactions.

ENHANCING SYSTEMIC INTERVENTIONS BY USING A SYSTEMIC MULTI-METHODOLOGICAL FRAMEWORK

Professor Alberto Paucar-Caceres[1], Dr Maria Alejandra Castellini, Dr Leila Abuabara
[1]Manchester Metropolitan University

Parallel 2 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 13:15 - 14:45

Biography:

Professor Alberto Paucar-Caceres is systems scientist, specializing in the field of Systems Thinking, Creative problem solving, Management science and Systems Science. Experience in application of systemic thinking and systemic methodologies to: sustainability and environmental management; transition to the CE; recycling; reducing and managing food waste and sustainable consumption. Alberto's research interest is in the area of application of systems thinking. In particular: (1) application of systems methodologies (Problem-structuring methods, and 'Soft' Operational Research) to problematic situations in organisations; and (2) application of systemic management science methodologies to environmental management and sustainability. Publication record includes 150+ academic articles in refereed journal papers, and more than 200 conference papers. Portfolio of research outputs in international journals: European Journal of Operational Research; Journal of Operational Research; OMEGA; Systems Research and Behavioural Research; Systemic Practice and action Research.. All of these articles are supported by a substantive corpus of other work.

Current projects:

1) Applying Circular economy systemic principles to Food Waste management

2) Promoting ecological and environmental awareness in HEIs

3) The role of higher education stakeholder networks for sustainable development: a systems perspective

4) Health Literacy and Planetary Health in Latin America.

The paper proposes a 'Systemic Multi-methodological Framework' for multi-methodological management science/operational research (MS/OR) interventions. Based on Mingers' framework for mapping MS/OR methodologies/methods/techniques, we advance a systemic framework to enhance the systemic intervention in a textile SME in Argentina. The framework draws from the key elements of Flood & Jackson's and Mingers' concepts for

multi-methodological practice. We discuss both the practical difficulties of applying Mingers' notional systems in a real-world and the cultural and psychological obstacles that prevent the viability of a multi-method and multi-paradigm intervention. Working with stakeholders from different levels of the Argentinean small and medium-sized enterprise (SME), we test the framework and discuss the insights useful to overcome these obstacles. By proposing an original framework (and by illustration, a real-world application), we aim to contribute to the debate about the current increasing multi-methodological practice in MS/OR.

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Structuring decision problems and generating alternatives: report of a workshop

Dr. Irene Pluchinotta[1], Ke (Koko) Zhou, Prof. Alexis Tsoukiàs
[1]University College London

Parallel 2 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 13:15 - 14:45

Biography:
Irene Pluchinotta is a Senior Research Fellow at the Institute for Environmental Design and Engineering, University College London. She is Senior Honorary Research Fellow at the Management Science Dpt. (University of Strathclyde) and Invited Associate Professor at LAMSADE (Paris Dauphine University). Her areas of expertise include System Dynamics and Soft OR applied to facilitate decision-making processes in multi-stakeholder settings. Based on a double PhD in environmental engineering and computer science, her work provides support to decision-makers involved in the generation and evaluation of environmental alternatives and policies. She developed a participatory methodology for the generation of alternatives, integrating Soft OR and Design Theory.

Problem structuring and alternatives generation are important and highly interconnected stages of decision-making and decision-aiding processes. A wrong problem formulation or a dull set of alternatives have a significant impact on the quality of the final decision. This is emphasised when complex multi-actor decisions need to be supported. Problem structuring methods are largely recognized for their valuable contribution to decision-making processes, both in theory and practice; on the other side, the alternatives generation phase is often overlooked, leading to unsatisfying decisions. Yet, alternatives are generated before being analysed, explicitly or implicitly, formally or informally.

Within this context, firstly, this talk presents the preliminary lessons learnt from a collaborative activity carried out with international OR experts involved in a pilot experiment workshop. The focus of this activity was the problem formulation and alternatives generation phases occurring between a client with a house retrofitting decision and six analysts using different OR methods. The objectives of the pilot experiment workshop were: to observe and discuss how different approaches dealt with structuring decision problems and generating alternatives, and to share experience on procedures which might be transferable. Secondly, we aim to organize a larger scale experiment workshop and this talk represents an opportunity to gather further insights from the OR community. The collaborative activity included colleagues from University College of London (UK), Paris-Dauphine University (FR), University of Strathclyde (UK), Politecnico of Milano (IT) and Politecnico of Torino (IT).

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MuVAM (Multi-Values Appraisal Methodology): a new software combining the Strategic Choice Approach and the Analytic Hierarchy Process

Professor Isabella Lami[1]
[1]Politecnico Di Torino

Parallel 2 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 13:15 - 14:45

Biography:

Isabella M. Lami, graduated with honors in Architecture, Ph.D in Real Estate and Urban Planning, MSc in Real Estate and Urban Planning, is Professor in Planning Evaluation and Project Appraisal at DIST, Politecnico di Torino, Italy. She is an expert in urban and territorial transformation assessment procedures, both qualitative and quantitative, with a particular focus on the multi-dimensionality of the aspects involved and the integration of the different phases of the decision-making - design process. In this regard, she has extensive experience in Multicriteria Decision Analysis (MCDA), Problem Structuring Methods (PSMs) and decision-making processes in the context of urban and territorial transformations, as well as in the management of participatory processes. Besides this area, another line of research concerns theoretical reflections and the development of models for the evaluation of sustainability in urban areas.

The importance of problem structuring—and Problem Structuring Methods (PSMs) specifically—for Multi-Criteria Decision Analysis (MCDA) has been acknowledged in the literature and practices of the last decades. This depends on the recognition that problem structuring is central to providing a richer view of the problematic situation for the subsequent phases of MCDA. However, little attention has been directed to an opposite point of view, reflecting on any aspects or weaknesses shown by PSMs in the process that can be balanced through integration with MCDA.

The presentation starts from a new multi-methodological framework combining a PSM and a MCDA to address the problem of composing facts and values in the decision-making process of policymaking, recently proposed to the academic discussion with an article published on EJOR (Lami and Todella, 2023). SCA enables the detection of relevant issues in the decision problems and their articulation in alternatives. At the same time, the integration with AHP allows the hierarchization of alternatives in an aggregated evaluation and, in so doing, discussion of the problem to be faced in a more transparent—and more structured—manner.

This approach relies on a new software called MuVAM (Multi-Values Appraisal Methodology), which is the focus of this presentation. MuVAM is a web application designed to support decision-making processes related to complex problems, equipped with a very effective online graphical interface. MuVAM works with a series of algorithms in the background to guide participants through five steps aimed at: representing the problem, identifying possible solutions, identifying decision criteria and their weights, comparing solutions and illustrating results. Attachments, links and map representations can be included to support the process. Lastly, it can be used by groups working in real time, in presence or remotely, or in asynchronous mode, allowing them to participate in the same workshop from anywhere, even deferred.

The software has been used in several structured workshops held in various European universities (in Turin, Paris, Bratislava, Tirana), in master's degree courses, doctoral courses and master's courses for lifelong learning.

The presentation illustrates some of these applications to show the potential of MuVAM.

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Aiding Social Enterprises: A Second Order Cybernetics Perspective

Dr Adrian Small[1], Dr Stephen Harwood[2], Dr Rebecca Dutson[1]
[1]Northumbria University, [2]Edinburgh Universty

Parallel 3 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 14:45 - 15:45

Biography:

Adrian is an Associate Professor of Operations Management. His main research activities are focused

around the area of process improvement, continuous improvement, Lean and Lean implementation in both

manufacturing and service contexts. Adrian also undertakes research in problem structuring methods

(PSM), information systems, and Industry 4.0.

Social Enterprises have special needs in terms of business support. Their social impact orientation can conflict with their need to be financially viable and 'make money'. Support agencies do not appear to appreciate this situation with social enterprises feeling left in a quandary. This can lead to an identity crisis. The challenge is to establish how this can be resolved. This can be viewed as a complex problem as it involves different stakeholders with a vested interest in the success of social enterprises and that there is ambiguity and uncertainty about how to handle. Consequently, a Problem Structuring Method (VIPLAN Methodology (VM)) is used in a pilot workshop setting to guide a small group of individuals, each representing a Social Enterprise in the NE of England, to explore the issues they face and establish a course of action to address a prioritised defined problem. The workshop was followed up three months later with individual interviews to examine the impact of the workshop upon their Social Enterprise activities. The findings from this pilot study demonstrated that the use of the VM was successful in generating useful change.

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Complexity and Variety in Viable Systems: A literature review

Dr Ayham Fattoum[1], Dr Chris Smith
[1]University Of Manchester

Parallel 3 - Soft OR & Problem Structuring Methods, Room 3.5, September 12, 2023, 14:45 - 15:45

Biography:
A lecturer in Soft OR at the University of Manchester. The main research interests involve applying the Viable system model (VSM), Soft systems methodology (SSM) and systems thinking principles to enhance systems' resilience and viability. Recent research focuses on applying VSM to the disaster and VUCA contexts to enhance the resilience of systems and societies. Previous experience in the not-for-profit and industry sectors involves quality management, HR, and change management.

In this paper, we undertake a more in-depth investigation of possible ambiguity about the concepts of variety and complexity in the VSM literature. VSM define variety by borrowing the original concept from cybernetics. It also addresses different characteristics of complex settings that are taken from cybernetics and systems thinking. Despite this, VSM studies seem to use these terms interchangeably and interpret them subjectively. Casual and unregulated interpretations and application of these concepts can have implications on practice and theory development. Studies that investigate the use and definitions of complexity and variety do not exist. Therefore, we have conducted a comprehensive literature review to explore how the concepts of complexity and variety are defined and used in VSM studies. The findings suggest that these terms are often interpreted according to need which has created scattered and inconsistent definitions and maybe miss use. To interrupt this arbitrary process, we combine the classical definitions proposed by VSM with the lessons learned from the findings to propose definitions of complexity and variety. This research contributes to the VSM literature by providing insight into the use and the practicality of the concepts of variety and complexity and offers a proposed path for developing VSM's complexity management theory and practice.

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Strategic Options and Development Analysis (SODA) and the Advance of SDGs´ strategic planning

Msc Renata Aguayo[1]
[1]University Of Freiburg

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:

Brazilian Forest Engineer, MSc in European Forestry, and currently pursuing a Ph.D. in Sustainable Development at the University of Freiburg.

Throughout my academic and professional life, I had worldwide experiences living in Brazil, Canada, Finland, Romania, and Germany, which contributed to building a broad overview of the forestry sector and its sustainable management, successfully improving my forestry understanding, intercultural skills, and self-development.

The aspirations for the future are to put all knowledge and experiences together, contributing to sustainable development and sustainability, by spreading sustainable business principles, improving stakeholders' engagement, and promoting environmental, economic, and societal changes.

Important discussions related to climate change and the use of natural and sustainable resources instead of fossil fuel materials have gained attention and opened up discussions. Countries and governments have agreed to more sustainable actions to stop climate change and support sustainable development. The development of new tools and frameworks to measure sustainable development has gained strength, and among many initiatives, in 2015 the United Nations created the Sustainable Development Goals (SDGs), a set of 17 objectives that aim to, among many other goals, to improve work conditions, to stimulate conscious production and consumption, and to guarantee life on earth. Forests provide sustainable forest materials and have huge potential to tackle climate change. To help addressing the complex relationship between SDGs and the forest sector, the use of Soft Operational Research (Soft OR) methods and more holistic approaches are very welcomed. Soft-OR methods carry the analysis further by adding a more formalized representation of the problem, particularly the development of structured models that provide a focus and language for discussion (Belton and Stewart, 2002). Rosenhead (1989) calls this alternative paradigm the ‘‘problem structuring’’ approach. This study will explore the methodology known as Strategic Options Development and Analysis (SODA), which has been developed to help with strategy formulation processes. SODA uses cognitive and causal mapping to express the thoughts and opinions of decision-making groups, engaged in a given subject in order to support strategic thinking. SODA can be used in a combination of steps, such as:

Individual interviews; Modelling, and Analysis; Group workshops; Monitoring, and evaluation. The expected results will be a practical overview of how the forest sector can contribute to a positive impact toward SDGs, enabling the creation of roadmaps, guidelines, and frameworks for sustainable development in the forest environment.

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Delivery through complexity in a large government department: Integration of data exploitation, analytics and systems thinking in HM Revenue and Customs.

Dr Ben Follows[1], Mrs Andrea White[2]
[1]HM Revenue & Customs, [2]HM Revenue & Customs

Parallel 6 - Soft OR & Problem Structuring Methods, Room 5.1, September 13, 2023, 16:00 - 17:00

Biography:

Ben is a senior OR manager with 20 years plus experience working within the Government Operational Research Service (GORS) mainly for HM Revenue and Customs. Ben's current role is to lead a set of cross cutting strategy and innovation analysis teams, to build capability and inform HMRC transformation and strategy. Ben has a wide ranging interest in the practical applications of OR in Government, ranging from systems thinking, Soft OR, evaluation, modelling, insight and data analytics.

Link to GORS: http://www.operational-research.gov.uk/recruitment

Like other large organisations, HMRC faces many challenges to improve customer service, reduce cost to serve and increase compliance through transforming processes and investing in new technologies. The interactions between colleague experience, customer service, customer experience, tax complexity and compliance are numerous and complex and mean that simple solutions are rarely appropriate. This presentation explores how analytical teams in HMRC have approached this complex system, and how we are using a variety of OR tools ranging from Systems Thinking to Data Analytics to develop actionable insight, and inform strategy and transformation.

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A pragmatic journey to automation, taking a risk-based approach to help low tech clients better analyse disparate data sets

Ms Charlotte Watson[1], Mr Callum Giblett[1]
[1]KBR

Parallel 6 - Soft OR & Problem Structuring Methods, Room 5.1, September 13, 2023, 16:00 - 17:00

Biography:
Callum is a leading consultant within KBR and specialises in helping clients think through some of their most complex challenges. Callum is highly data and tech focused, stemming from a data management background in process engineering applications. Applying a process engineering style to business systems has been a key strength of Callum's approach. Callum likes working in an environment where he can focus on the system, boundaries, interfaces, applicable technologies, and data techniques as a holistic solution. Callum has delivered value across a range of sectors with recent expertise in Government, Policing and Nuclear.

A significant proportion of the challenges relating to data management across the public sector can be traced back to the procurement and development of disparate management systems, resulting in data sets that are hard to understand in isolation, never mind as an aggregated set. Whilst there is always a high tech solution, for low tech clients this is sometimes out of budget, appetite, or both. KBR recently worked with a public sector client that wanted to bring to life their data from across a range of tools hosted on different IT systems. The data that was required was situated across a span of different locations, held in different tools, and stored in different formats. Some initial work had shown that it was possible to analyse the data, but the manual trawl had taken six months. Whilst a necessary and essential first step, a manual process was entirely unsustainable and could not be rolled out as a credible business process. This talk will show our approach to developing an automation pathway, and how we overlaid the pathway with a set of key barriers and potential mitigations to facilitate the journey to a more technically mature solution. Our approach aligns with standard risk-based techniques but has been applied to data automation to help low tech clients, such as those hampered by system constraints, achieve better data management outcomes.

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KEYNOTE: Sustainable Self-governance in business and societies: the Viable System Model in Action

Dr Angela Espinosa[1]
[1]University of Hull

Parallel 8 - Soft OR & Problem Structuring Methods KEYNOTE: Angela Espinosa, Room 3.1, September 14, 2023, 09:00 - 10:30

Biography:

Angela is a computer and systems engineer from Los Andes University (Colombia. 1981) and holds a PhD in Organisational Cybernetics from Aston Business School (UK, 1995). She has been an international leader in developing Organisational Cybernetics, a theory for effective organisation and complexity management in organisations pioneered by Professor Stafford Beer. Angela worked closely with S Beer and since he passed away in 2002, she has co-led the Metaphorum, a non-for-profit members association to develop his legacy. She has advised governments, businesses, and communities in more effective ways of self-organising and being socially and environmentally responsible in several countries in Latin America, the United Kingdom and Europe.

Angela was a Reader in Cybernetics in Hull University Business School (2002-2018); and an Associated Professor in several universities in Colombia. She has published extensively books, research monographs, book chapters and papers on applications and developments of Beer's theory (the Viable System Model), in the European Journal of Operational Research and in other systems and cybernetic journals. 'Sustainable Self-Governance in Businesses and Society: the Viable System Model in action' published by Routledge in 2023, summarises her recent work and applications. She was invited to deliver the 'Ashby Lecture', in 2002, by the International Federation of Systems Sciences; she received the 'Norbert Wiener Award' in 2007, by Emeraldi Literati; she gained two EPSRC Fellowships in 2007-2010. She is now a Fellow of the Cybernetics Society (FCybS), an honorary Research Fellow at Exeter University; an invited fellow in Buckingham University & Transilvania Executive Education; and an Emeritus Fellow in the Centre of Systems Studies at Hull University.

In this talk I will brief the 'Viability and Sustainability (v&s)' approach - my own developments to Beer's 'Viable System Model,' (VSM) a theory of effective organisation, inspired in cybernetic ideas on neural networks. I will explain how the original VSM theory can be clarified to facilitate improvements in self-governance and adaptive capabilities in businesses and societies to progress faster towards sustainability. I will also introduce an effective soft OR toolkit inspired in the v&s approach: the VSM constitutive rules, and the

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Self-Transformation methodology, to facilitate VSM implementation and to support systemic change. I will illustrate the power of this approach through selected examples of application in the last three decades in organisations of different scales operating in a variety of places and contexts, where it has been used to facilitate systemic change to support more sustainable governance. I will then reflect in open research paths to improve this toolkit and for further developing the VSM as a soft OR approach.

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Breaking (out of) the dichotomous framing of problems in OR practice

Professor Mike Yearworth[1,2]
[1]University of Exeter, [2]Grounded Systems Ltd

Parallel 9 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 11:00 - 12:30

Biography:
Mike has a background in engineering and management and is Emeritus Professor of Management Science at the University of Exeter.

He works with organisations on the following:

- Strategy-making with senior leadership teams

- Group decision and negotiation through conventional workshops and online group support systems

- Systems modelling for managing risk

- Multi-organisational collaboration

Mike's preferred way of facilitating workshops with leadership teams is to work online in 1:1 and group sessions supported by strategyfinder, as developed by Colin Eden and Fran Ackermann. He uses a variety of Problem Structuring Methods (PSMs) including:

- Hierarchical Process Modelling (HPM), supported by root definitions/CATWOE, process performance scoring, and Argumentation

- Causal Loop Diagrams

- Multimethodologies using augmented qualitative analysis techniques

Recent work by Dyson et al and others has questioned the division between 'Hard' and 'Soft' OR and the damaging impact this is having on the wider practice of OR. The dichotomous framing of problems set out in the original critiques of OR, that led to the establishment of Problem Structuring Methods as a distinctive field, has remained more or

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less unchallenged and reinforced the separation. The prospects for repairing the Hard/Soft divide within OR are discussed from three perspectives; i) Chaos of Disciplines, ii) Actor Network Theory, and iii) Pragmatism.

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Harbinger of PSM thinking? Reflections on Forrester's 'Industrial Dynamics

Prof David Lane

Parallel 9 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 11:00 - 12:30

This talk reflects on Forrester's Industrial Dynamics, a founding text of the field of system dynamics modelling, published some six decades ago. It touches on the influences and published antecedents of the book. It briefly considers some contemporary reactions, drawn from a range of disciplines. Its central interest is how the ideas in the book relate to MS/OR thinking then and now; what their contribution was to System Science; and whether they anticipate later developments in PSMs and 'Soft OR'. It closes by observing that the provenance of those ideas can be seen in the varied life of Forrester himself, and that the book continues to serve as a font of ideas for system dynamicists and others across OR.

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Unravelling the Hurdles in the Fusion of Design Thinking and Systems Thinking

Prof Ali Owrak[1], Dr Chris Smith[1], Mr Martin Russell[2], Mr Kevin Collins[2], Miss Larissa Niedecken[2]
[1]The University of Manchester, [2]Fujitsu

Parallel 9 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 11:00 - 12:30

Biography:
Dr Ali Owrak is a Professor in Service Systems and Digital Business at Alliance Manchester Business School. Dr Owrak holds a PhD in Computer Science from The University of Manchester. His research interests focus on digital transformation for organisations and how they can bring digital technologies and platforms to improve decision making at an organisational level. Dr Owrak leads several major collaborative partnerships with multinational IT service providers in digital transformation on behalf of Alliance Manchester Business School. He was recently awarded the University of Manchester teaching award for Educational Leadership and Inclusive Education.

Dr. Chris Smith is a Senior Lecturer in Operations and Critical Supply Chains at Alliance Manchester Business School. Dr Smith holds a PhD in Management Science from Warwick University. Dr Smith has published in world leading elite journals such as The European Journal of Operational Research and The Journal of the Operational Research Society. His research interests focus on how to help organisations and managers make better decisions when there is overwhelming complexity. Dr Smith focuses on action research projects on practical problems where insights can be derived from a situation by making change in that context leads to learning about both theory and the context in which that change is made. He has recently been focussing on understanding how organisations and managers can make better informed decisions around social sustainability in their operations and supply chains by using technology. Dr Smith has worked on several funded projects including the European Commission funded UScore2 Project and the Integrated Service Delivery project with Warwickshire Police.

This paper considers the different ways in which systems thinking approaches can be integrated with design thinking to enable diverse organisational and policy decision makers develop better outcomes. This research project is situated within Fujitsu Europe's bespoke design thinking programme termed Human Centric Experience Design (HXD). HXD has been defined by Fujitsu as a programme that is challenge oriented, with a focus on delivering

progress on problems as identified by their customers. They are exploring how augmenting HXD with systems thinking approaches may give a more holistic view to their strategic account management and the solutions they co-design with their customers. This project works with Fujitsu to identify challenges for HXD and provide practical solutions drawing from Systems Thinking and Design Thinking.

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The Tetrahedron: A Framework for Developing Coherent Strategy for Complex Environments

Dr Tim Forsyth[1], Dr Natalie Clewley[1], Mr Aydin Asena[1]
[1]Cranfield University (Defence and Security)

Parallel 10 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 14:30 - 16:00

Biography:
Tim joined the Complex Systems Governance Group at Cranfield University as a Lecturer in 2021 and is Course Director for the new Level 7 Systems Thinking Practice Apprenticeship and MSc. Having navigated an unconventional career path that includes a Batchelor of Engineering Degree and a Social Science PhD, Tim studies the relationships and structures formed between people and organisations; and the strategies of governance, leadership and management that contribute to work-related stress, depression and anxiety. In this regard, Tim's principal research interests lie at the interface of sociotechnical systems and peoples' subjective experience of challenge in complex organisational environments. His most recent research activities have included utilising soft methodologies to design and develop a national research network, bringing together academia, industry and government.

Strategy is an 'intellectual construct' linking where you are today with where you want to be tomorrow in a substantive, concrete manner (Sullivan and Harper, 1998). This makes sense in theory, but in today's complex world, we cannot effectively cross the space between today and tomorrow with an intellectual construct any more than we can cross a canyon with an imaginary bridge. Moreover, the variety of perspectives that may be involved in developing strategy across groups and teams exacerbates this problem further. To address these challenges, an approach is required that provides a means by which strategy can be drawn out of the conceptual space and moulded into something substantive, explicit and load-bearing. This presentation proposes a novel conceptual framework, enabling practitioners to move strategy beyond an intellectual construct into an explicit context-specific bridge between where we are today and where we want to be tomorrow.

The proposed framework utilises a set of six well-established concepts, but integrates them in a way that makes effective use of the interrelationships between the concepts. These six concepts include purpose, space, behaviour, method, application and innovation – all of which are crucially important to the problems faced by management and leadership under the demanding conditions of a modern organisation. A tetrahedron (a pyramid shape with a three-sided base) model is used to encapsulate this system of interrelationships. Its 3D nature adds an additional benefit to designing strategies by indelibly linking the abstract

concepts (purpose, behaviour, space) to operational concepts (method, application, innovation).

By systematising these concepts and therefore reducing the disjointedness with which these concepts are often considered in the context of busy organisations, the tetrahedron provides practitioners with an explicit set of principles in an integrated structure to develop strategic approaches for solving complex, wicked problems. This will ultimately support managers and leaders in naturalistic decision-making (Klein et al., 1993) under conditions of uncertainty and ambiguity, generating coherent strategic plans and not just descriptions of desired end states (Chilcot Report, HMG, 2016).

PS as a commonplace everyday activity

Dr Eleanor Reynolds[1]
[1]Warwick Business School

Parallel 10 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 14:30 - 16:00

Biography:
Eleanor's PhD research at Warwick Business School considered Problem Structuring in an everyday workplace. Alongside her research, Eleanor has taught in the areas of PSMs, strategy development and organisation studies and looks forward to continuing her teaching work at Warwick over the next academic year. Prior to her research, Eleanor accumulated 12 years experience in the water industry working in a wide variety of roles and completing her MSc in Business Analytics and Consulting during this period.

This talk reviews a 21-month single-site ethnographic study of how people structure problems in an everyday workplace. Everyday PS is described and illustrated as a commonplace activity, not labelled PS by those who nevertheless seek to comprehend wicked, messy, swampy situations, perceive choices available, and agree upon meaningful action. Key differences between everyday PS and OR PSM interventions are identified, with more detailed analysis leading to the development of an organisational perspective on PS. Implications for OR practice are considered, with a focus upon identifying PSM principles and skills that are relevant to the everyday PS context.

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Systemic PSM as a Specialist Enterprise: enhancing the theory of adoption of applied systems thinking

Dr Michael CHARLTON[1]
[1]Sheffield Business School

Parallel 10 - Soft OR & Problem Structuring Methods, Room 3.9, September 14, 2023, 14:30 - 16:00

Biography:
Senior Lecturer at Sheffield Business School since 2011 following a 15-year career in industry. Subject Group Operations Lead for the Business, Operations and Systems (BOS) subject group teaching across a range of modules, specialising in digitalization, systems thinking, project management and strategic management. A former senior commercial manager in the clothing industry and a project consultant in the public sector. Managed several successful IT projects including the implementation and development of ERP, CRM and forecasting systems. Managed a portfolio of housing capital projects, including a major investment in a flagship housing regeneration scheme.

Educated at the University of Hull, receiving a BA (Hons) in Management Systems (1989). Graduate from the University of Nottingham with an MBA (2007). Successfully defended PhD thesis Ways of Seeing Wholes: Systemic Problem Structuring Methods for the Uninitiated in 2022. Professional and research interests lie in the development of systems thinking and problem structuring methods (PSMs) to help improve the definition and delivery of successful projects and to aid innovation in services.

Systemic PSM as a Specialist Enterprise

Softer forms of systems thinking and Soft-OR provide the theory, the methodology and the methods by which managers can see the situations they are trying to manage as wholes. They facilitate what has become known as “bigger picture” thinking and are generally thought of as effective ways to manage complexity. But despite more than 50 years of development, the extent to which these ideas have penetrated mainstream management thinking and practice is limited. Existing research suggests that adoption of systems thinking, and the family of approaches known as “systemic PSMs”, is frustrated by a number of factors, not least by the definition of systems thinking itself. But questions about the take-up or adoption of systemic PSMs remain under-theorised. This presentation aims to deepen our understanding of how managers receive and take-up, and sometimes repudiate, systemic PSMs. It reports findings from four interventions in four very different organisations. The findings are interpreted through the lens of Luhmann’s complex social systems theory. Applications of softer forms of systems thinking are better received and are

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more likely to be taken-up in situations where an existing organisational decision premise is contested in some way and no longer functions as a stable reference point for future decisions. In these circumstances, managers may show greater curiosity in systemic PSMs and are more willing to adopt them to generate new "ways of seeing". However, there are significant obstacles to widespread adoption, and where managers perceive that the use of systems approaches results in over-specifying plans for the future, resistance to systems thinking and systemic PSMs may be encountered. Drawing on Luhmann's (2018) theory of how organisations are constituted by decision communications, this presentation advances an argument for a more nuanced understanding of the circumstances in which systemic PSMs might be needed and effectively deployed, ultimately leading to the conclusion that use of systemic PSMs is a specialist enterprise. This may change the way we think of systems thinking and systemic PSM in their "commodified" form, narrowing the range of potential application.

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Supply Chain and Logistics Analytics

Metaheuristics methods to solve continuous facility location and transportation mode selection in the supply chain

Mr ABDULAZIZ ALAGEEL[1], Dr Martino Luis[2], Dr Shuya Zhong[3]
[1]University Of Exeter, [2]University Of Exeter, [3]University Of Exeter

Parallel 2 - Supply Chain and Logistics Analytics, Room 4.10, September 12, 2023, 13:15 - 14:45

Biography:
A PhD candidate in the School of Engineering, University of Exeter. He holds a BEng in electrical engineering as well as an MSc in the international supply chain from the University of Exeter. His work focuses on designing and optimization sustainable supply chains, considering different problems and layers using mathematical models and programming. Abdulaziz presented his work at four different international conferences.

The purpose of this study is to understand the challenges faced when determining the location of a facility and selecting the mode of transportation within a supply chain network while considering carbon emissions. In this study, we aim to (i) locate facilities (such as distribution centers) in continuous space, taking capacity limitations and opening costs into account, and (ii) reduce carbon emissions by choosing transportation mode. The problem is formulated as a mixed-integer linear programming. This study hybridised a greedy randomised adaptive search (GRASP) and variable neighborhood search (VNS) to deal with the problem. In order to assess the performance of the proposed method, well-known datasets from the literature are utilized and adapted. In addition, the study emphasizes some research avenues for future study based on a computational analysis of the proposed hybrid method.

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Drone-assisted routing problem with pickup and delivery service

Phd Candidate Shanshan Meng[1]
[1]Loughborough University

Parallel 2 - Supply Chain and Logistics Analytics, Room 4.10, September 12, 2023, 13:15 - 14:45

Biography:
Shanshan Meng, female, a phd visiting student from Loughborough University. She major in truck-drone combined routing problem and the latest study was published on the 《Transportation Research Part E: Logistics and Transportation Review》.

Unmanned aerial vehicles, commonly known as drones, have gained wide attention in recent years due to their potential of revolutionizing logistics and transportation. In this paper, we consider a variant of the combined truck-drone routing problem, which allows drones to serve multiple customers and provide both pickup and delivery services in each flight. The problem concerns the deployment and routing of a fleet of trucks, each equipped with a supporting drone, to serve all the pickup and delivery demands of a set of customers with minimal total cost. We explicitly model the energy consumption of drones by their travel distance, curb weight and the carrying weight of parcels, develop a mixed-integer linear programming model (MILP) with problem-customized inequalities, and show a sufficient condition for the benefit of the combined truck-drone mode over the truck-only mode. Considering the complexity of the MILP model, we propose a novel two-stage heuristic algorithm in which a maximum payload method is developed to construct the initial solutions, followed by an improved simulated annealing algorithm with problem-specific neighborhood operators and tailored acceleration strategies. Furthermore, two methods are developed to test the feasibility for both trucks and drones in each solution. The proposed algorithm outperforms two benchmark heuristics in our numerical experiments, which also demonstrate the considerable benefit of allowing multiple visits and both pickup and delivery operations in each drone flight.

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Optimising the Use of Drones in Medical Logistics in the UK as Part of A Mixed-Mode Fleet

Mr Andy Oakey[1], Dr Antonio Martinez-Sykora[1], Prof Tom Cherrett[1], Dr Matt Grote[1]
[1]University Of Southampton

Parallel 2 - Supply Chain and Logistics Analytics, Room 4.10, September 12, 2023, 13:15 - 14:45

Biography:
Andy Oakey is a logistics and transport researcher at the University of Southampton. Working in both the Transport Research Group and the Southampton Business School, Andy's research focuses on bringing practical assumptions and management into OR within the field of multi-mode logistics. He is also the Vice Chair of the ITS UK Freight Forum, where he engages industry, government, and academia in discussing the challenges and solutions in freight.

The use of aerial drones (a.k.a. Uncrewed Aerial Vehicles, UAVs) in logistics is becoming more widespread, though evidence from previous studies and trials is suggesting that they may not be the complete answer to many of the industry's challenges. Accurately accounting for challenges, such as energy consumption, emissions, and cost is important to the NHS, who are looking to improve their patient care and sustainability whilst reducing costs.

This study seeks to model multiple case study areas across the Solent region of the UK, identifying the ideal combinations of vans, bikes, and drones for maximum impact. Using a suite of tools developed as part of the study, accurate emissions and energy data, and risk and energy optimised drone trajectories are captured before they are subsequently input into a mixed-mode optimiser. Utilising a novel algorithm, based on the Clarke and Wright Savings Algorithm and a variation on a Best-Fit Bin Packing Algorithm, different scenarios using these results are tested.

Modelling drones using realistic data and assumptions is a key contribution of this study, with literature often neglecting key technology limitations or regulator-imposed restrictions. Both the drone flight planning tool and the vehicle route optimisation algorithm are also novel and present a means to optimise multiple modes for the collection of patient samples from community clinics.

Model results suggest that unless costs are reduced to less than a fifth (18.5%) of their current levels, and other operating criteria are met, drones do not offer sufficient benefit over existing logistics modes to warrant being selected for cost purposes alone. When alternative objectives are explored their application has greater benefits, such as expedited

delivery and reduced emissions, though a trade-off with costs is seen. For example, delivery times can be reduced by up to 90%, however, costs would be 117% higher as a result.

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Multi-Purchase Choice Models for Assortment Optimisation of a Sequential Purchasing Process

Miss Kexin Lai[1], Professor Christine Currie[1], Dr. Selin Ahipasaoglu[1]
[1]University Of Southampton

Parallel 3 - Supply Chain and Logistics Analytics, Room 4.10, September 12, 2023, 14:45 - 15:45

Biography:
Kexin is a PhD student in the Operational Research Group within the School of Mathematical Sciences at the University of Southampton. Her research direction is primarily focused on revenue management, with a particular emphasis on assortment optimisation and customer choice modelling.

We consider the situation where customers make a finite sequence of purchase decisions and buy at most one item at each stage, where the sets of items on offer at each stage are disjoint. Our aim is to optimise product assortment and/or prices at each stage to maximise overall expected revenue and/or customer satisfaction. The basis of the optimisation is a choice model that accurately describes how customers make purchase decisions (if any) at each stage. We consider two choice models: a single-stage bundle-purchase model (also known as the Multivariate Multinomial Logit model, MVMNL) and a multi-stage sequential purchase model.

Under the single-stage model, we assume that customers form a choice 'bundle' by selecting at most one item from each product set. We model this behaviour similarly to the standard multinomial logit model (MNL), where customers choose the utility-maximising bundle. In the multi-stage sequential choice model, customers make a sequence of choices, where the choice made in one stage depends on the choices made in the previous stages. We include product interactions in both models to account for product compatibility.

Previous literature on multi-purchase choice models mainly concentrated on investigating customer behaviour when selecting multiple items from a fixed set of products within a single category, or the case of choosing one item from every predefined category. We consider the situation where customers make choices among a different set of items at each stage, where the sets of items could be drawn from one or more categories.

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Customer Picking Behaviour in Retail Inventory Management: The Roles of Sustainability Messages and Price Discounts

Thomas Vogt[2], Dr. Anna-Lena Sachs[1], Professor Ulrich Thonemann[2], Mr Ben Lowery[1]
[1]Lancaster University, [2]University of Cologne

Parallel 3 - Supply Chain and Logistics Analytics, Room 4.10, September 12, 2023, 14:45 - 15:45

Biography:
Ben Lowery is a first-year PhD student at the STOR-i CDT at Lancaster University. His research focuses on inventory control, with particular interest in stochastic inventory policies.

Customer picking behaviour plays an important role in retail inventory management. Standard inventory models usually distinguish between picking the freshest items (Last-in-first-out) or the oldest items first (First-in-first-out). We analyse how picking behaviour affects inventory management in retailing, and whether sustainability messages and price discounts can change customer picking behaviour to increase sales of earlier expiring items and reduce food waste in retailing. We conducted an online experiment where subjects chose between earlier expiring and longer lasting items using monetary and non-monetary incentives. We find that 1) sustainability messages induce more subjects to buy earlier expiring items; 2) higher price discounts increase sales of earlier expiring items; 3) some subjects do not change their behaviour, or crowd out with price discounts. Understanding how different customer types respond to incentives helps retailers to offer them only to customers who most likely respond with buying expiring items. We further evaluate the impacts of these findings on inventories by considering a periodic review model for perishable items with age-dependent lifetimes.

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Deploying buffering strategies in pork meat supply chains to deal with disruptions: a system dynamics approach

Dr Saeed Taheri[1], Dr Sander de Leeuw[1]
[1]Nottingham Trent University

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Saeed is a Senior Lecturer in Oerations and Supply Chain Management at Nottingham Business School. An engineer by background, Saeed received his PhD from Nottingham Business School in 2018. Saeed's research pursuits are focused on systems sciences, with particular emphasis on the utilization of system dynamics modeling in diverse managerial and policy-based contexts. Through his research, he aims to develop a greater understanding of the complexities and interconnectedness that underpin organizational and societal systems, and to derive actionable insights for enhanced decision-making in these domains.

This paper explores the possibilities within pork supply chains to effectively manage unexpected crises that lead to disruptions in the supply chain. The focus is on evaluating supply chain strategies employed by a Dutch pork processor in response to the COVID-19 pandemic. The objective is to identify the optimal balance between buffering strategies in such crisis situations. By utilizing a system dynamics model, we conduct simulations to examine the behavior of the stocking system under various scenarios of supply chain disruptions, thereby subjecting the pork meat supply chain to stress testing. The model reveals the inherent trade-offs involved in decision-making processes, including the utilization of frozen inventory, and highlights the potential of the system to establish resilience for the firm while ensuring cost-efficiency and high service levels.

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Information Sharing in the Online Marketplace When Competing Sellers Make to Stock

Professor Hongtao Zhang[1]
[1]The Hong Kong University Of Science And Technology

Parallel 7 - Supply Chain and Logistics Analytics, Room 4.16, September 13, 2023, 17:00 - 18:00

Biography:
Dr. Hongtao Zhang is a professor of Operations Management at HKUST Business School (School of Business and Management, The Hong Kong University of Science and Technology). He has a BS in mechanics and an MS in control theory from Peking University, and a PhD in Operations Research from MIT. Dr. Zhang has served as a Senior Editor at Production and Operations Management (POM) since 2012 and co-edited a special POM issue on innovation and sustainability. He has published in leading journals such as Management Science, Operations Research, MSOM, and POM. At HKUST Business School, he has taught UG, MSc, MBA, and executive courses and has been twice awarded the Franklin Prize for Teaching Excellence. His research interest in recent years is in incentives and impact of information acquisition and dissemination in supply chains and online marketplaces.

Online retailing is now an integral part of the modern economy. Platforms like Tmall and eBay, as key players in linking sellers/suppliers with consumers, are engines of the growth of online retail sales. We investigate the incentives for and the effects of information sharing in the online platform where multiple sellers distribute their partially substitutable products.

A distinguishing feature of our study is that the competing sellers make to stock. The online platform has a demand forecast and may choose to share it with the sellers in the stocking period. Differing from the usual Cournot competition, the selling quantity a seller put up for sale in the selling season, when market demand realizes, is limited by, and may be smaller than, the stocking level built up before the selling season.

We have found that the uninformed seller sets a higher stocking level than the informed seller does. However, the expected selling quantities (prices) of all sellers, whether informed or not, are the same and are equal to the equilibrium quantity (price) corresponding to the certainty-equivalent case. Information sharing benefits (hurts) the informed (uninformed) sellers by increasing (reducing) their revenue. The online platform voluntarily shares information with more sellers when stocking cost is higher, or the commission rate is higher.

If the stocking cost is very low, sharing information will reduce the total revenue and thus the platform's earned commission, such that the platform will have no incentive to share

information. When voluntary information sharing is not possible, information sharing can be achieved through side payments because information sharing reduces the costs of all the sellers, informed or not, and the cost savings always dominate revenue loss.

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Subscription-based models for maximising profitability in e-grocery retailing

Mr David Winkelmann[1], Ms Charlotte Köhler[2]
[1]Bielefeld University, [2]European University Viadrina

Parallel 7 - Supply Chain and Logistics Analytics, Room 4.16, September 13, 2023, 17:00 - 18:00

Biography:
I am a PhD candidate at Bielefeld University, Germany. In my thesis I am using techniques from Operations Research and Data Science to tackle questions related to logistics operations and their applications in business. My research focuses on providing scientific decision-support, e.g. to optimize inventory management and storage assignment for a leading European e-grocery retailer. Currently, we are working on a project where the main goal is to help the retailer increase profitability by reducing uncertainty in customer demand. To achieve this, we are investigating the implementation of a subscription-based model for e-grocery retailing.

E-grocery retailing faces the challenges of narrow profit margins and high customer expectations. To provide excellent service to customers, retailers offer a wide product selection and short delivery times, which lead to high costs in inventory holding and inefficient delivery routes caused by uncertain customer demand. To address this, retailers aim to decrease demand uncertainty in order to reduce operational costs while increasing customer retention and profits.
This presentation proposes a subscription-based model for e-grocery retailing, where customers commit to a selection of products to be delivered at regular intervals. Conversely, companies offer benefits, such as discounts, as rewards. The benefits offered are calculated based on the expected savings for each subscriber, while higher benefits are likely to attract more customers to subscribe to a particular retailer. The subscription-based model can help to decrease demand uncertainty, improve operational planning, and enhance customer loyalty in the long run.

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A state-space approach to study the bullwhip effect under the rationing game

Dr Christos Papanagnou[1], Dr Andreas Seiler[2]
[1]Aston University, [2]Aston University
Parallel 8 - Supply Chain and Logistics Analytics, Room 4.1, September 14, 2023, 09:00 - 10:30

Biography:
Dr Andreas Seiler is Research Fellow at Engineering Systems and Supply Chain Management Group in Aston University. He holds a PhD in Economics and has worked for many years as a data scientist in several institutions and organisations. His research interests include, supply chain analysis, modellling and network analysis and data science.

Motivated by the disruption phenomena in supply chains when demand for goods exceeds supply, a stochastic state space model is introduced to study the impact of the rationing game on the bullwhip effect and inventory variations. The rationing game is modelled with the aid of a proportional gain factor, which adjusts the number of goods dispatched to the downstream supply chain nodes. A two-echelon supply chain is considered in this study, which consists of a single distributor that serves two retailers. It is assumed that inventory replenishment in each retailer follows base stock policies under customers' stochastic demand profiles. The dynamic properties of the supply chain model are encapsulated in a closed form covariance matrix, which is expressed as a function of the proportional control parameters and the percentage of the distributor's inventory that is dispatched to the retailers. The model is analysed under stationary conditions, allowing to analyse the effect of distributor's inventory variances and correlated demand profiles on the bullwhip effect (demand amplification) and related instability phenomena in supply chains.

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Network optimisation in the real world - going beyond a cost driven model

Mr Emile Naus[1]
[1]BearingPoint

Parallel 8 - Supply Chain and Logistics Analytics, Room 4.1, September 14, 2023, 09:00 - 10:30

Biography:

Emile leads the Supply Chain team in BearingPoint in the UK. During his 30 years in supply chain, he has designed, build and run global supply chains.

Before becoming a Partner at BearingPoint, he was Head of Logistics Strategy at Marks & Spencer and Long Term Planning Manager at Tesco.

He is passionate about using data, analytics and optimisation to improve business performance.

Supply chain design is a well researched topic in Operational Review. Typical solutions include a mixture of machine learning, mathematical optimisation and heuristic algorithms. Typically, these models are either cost minimisation or profit maximisation models, based on end-to-end operational costs.
Risk, flexibility and sustainability have always played a role in supply chain design, but often are not represented in the models. Over the past few years (pandemic, shipping disruption, labour disruption and cross-border trade issues across the world), these topics have become much more visible, and arguably become more important than just the financial evaluation of the supply chain models.
Using a recent case study, we will discuss how we can approach some of these factors and how we have started to include them in our supply chain models.
This is a practical example of supply chain modelling, and the modelling still has limitations; however, we will discuss the practical implications and restrictions.
Key elements include:
- impact on 'small' or 'large' changes from the model to real life solutions, and the actual implication on the model output (which is not intuitive or linear)
- Risk modelling integrated into the cost model (using two different modelling options)
- Flexibility modelling
- Impact of sustainability on models

WORKER AND JOB ASSIGNMENT TO PRODUCTION CREWS CONSIDERING POSITIVE EFFICIENCY SPILLOVER EFFECTS TO MINIMIZE THE MAXIMUM COMPLETION TIME

Dr Alex Ruiz-Torres[1], Belarmino Adenso-Diaz, Jose Ablanedo-Rosas, Shunichi Ohmori
[1]University of Puerto Rico

Parallel 8 - Supply Chain and Logistics Analytics, Room 4.1, September 14, 2023, 09:00 - 10:30

Biography:

Dr. Alex Ruiz-Torres is a full time faculty member of the Facultad de Administracion de Empresas at the University of Puerto Rico, Rio Piedras Campus. He currently serves as Chair of the Graduate School of Business. He also holds an adjunct position at Florida Atlantic University. He obtained industrial engineering degrees from Georgia Tech (B.), Stanford (M.S.) and Penn State (Ph.D). He teaches in the area of operations and supply chain management, offering undergraduate and graduate courses in production planning, lean and six sigma systems, logistics, and simulation. In 2019 and 2022 he received fellowships to conduct research work at Waseda University in Tokyo. He has also has been granted two Fulbright awards including the 2014 Fulbright - Aalto University Distinguished Chair (Helsinki, Finland). Dr. Ruiz-Torres has been the recipient of NASA faculty fellowships at the Kennedy Space Center and a NASA Small Business Technology Transfer grant. He has been a visiting lecturer at universities in Europe, the Middle East, and the Americas. He has consulted for manufacturing, logistic, and healthcare organizations in the U.S., Ecuador, Mexico, and China. He has over eighty journal publications, including articles in the European Journal of Operations Research, Computers & Operations Research, International Journal of Production Economics, Computers & Industrial Engineering, Omega, and the International Journal of Production Research. His research interests include production planning, supply chain models, simulation modeling, and the circular economy.

This research considers a production planning problem where a set of worker crews must complete a set of independent jobs. The time to complete each job is a function of the specific set of workers that make up a crew. There are multiple job types and workers have different efficiency levels for the job types. A key novelty of the studied environment is the consideration of a positive spillover effect; the case where the workers in a crew are positively affected by the worker with the highest efficiency, thus crew forming an important part of the planning process. The paper presents a mathematical formulation for the described environment and proposes several approximation heuristics for crew forming and job assignment. Experiments are conducted to test the quality of the heuristic approaches for small and medium sized problems.

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Sustainable Development Goals

AI and digital skills in the UK manufacturing exporting firms

Dr Aida Garcia-Lazaro[1]
[1]University Of Bath

Parallel 1 - Sustainable Development Goals, Room 4.8, September 12, 2023, 09:15 - 10:45

Biography:
I am an economist studying the impact of digitalisation on the labour market. I focus on AI and digital skills.

I am a Research Associate at the Institute for Policy Research, University of Bath, UK. I joined the Made Smarter Innovation: Centre for People-Led Digitalisation in 2021.

In my research, I use applied econometrics, machine learning and modelling to examine the topics I am interested in.

Previous work has focused on other dimensions of technological change and the effects on the labour share, Brexit and the labour market.

This paper examines to what extent the UK exporting manufacturing companies show a greater demand for AI and digital skills than their peers concentrated on the domestic market. We use the Lightcast dataset on online vacancies from 2012 to 2023 and match it with information from FAME to create a firm-level dataset that merges information on digital skills, exporting variables, and companies' financial and investment conditions. This study conducts two baseline analyses. First, it provides a detailed overview of the AI and digital skills dispersion across the UK for the manufacturing sector. Second, it assesses the causal effect of being an exporting manufacturing company and its AI and digital skills demand controlling for firm metrics and regional effects. This paper's preliminary results show a positive and significant impact between being an exporting manufacturing company and the demand for workers with AI skills. These findings are consistent with the intense international competition that exporting companies face in the global markets to keep the market share. We present additional analysis at the regional level to give insights into the levelling-up agenda. Finally, the paper shows a set of robustness checks to accompany our baseline estimations.

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Shedding light on the attitudes and behaviour at night: examining the relationship between public lighting and nocturnal mobility

Ms. Elodie Bebronne[1], Prof. Sabine Limbourg[1], Prof. Mario Cools[2]
[1]Hec Liège - Management School of the University of Liège, [2]University of Liège - Urban and Environmental Engineering - LEMA

Parallel 1 - Sustainable Development Goals, Room 4.8, September 12, 2023, 09:15 - 10:45

Biography:
Elodie Bebronne has graduated from a double degree in Industrial and Business Engineering, jointly organised by HEC Liège (University of Liège) and HELMo Gramme. She is part of the Business Analytics and Supply Chain Management research field since September 2020 and works as a PhD student. Her research focuses on connection corridors to enhance biodiversity conservation. This research is performed under the supervision of Prof. Sabine Limbourg.

Lighting is an essential aspect of our lives, but artificial light has received criticism for its negative impacts on the environment, wildlife, and health of people. Adequate lighting is crucial for creating a safe environment (in terms of road safety, criminality and feeling of safety), especially when using soft modes of transport. Poor lighting, on the other hand, can make people feel unsafe and uncomfortable, potentially deterring them from using these modes.

Our research offers four contributions. Firstly, it identifies the required characteristics of public lighting for safe and acceptable nocturnal mobility. Secondly, it analyses the attitudes and behaviours of the population towards public lighting, and the dark. Thirdly, it investigates how the night affects modal choices. Finally, it assesses citizens' willingness to accept reduced public lighting and how the energy crisis has impacted their judgement.
To gain insights into the attitudes towards public lighting of the population in the Walloon region, we conducted two surveys. The target population was individuals aged 16 and above living in the Walloon region. The first survey was administered online from 16th February to 29th March, 2022, resulting in a total of 677 responses. The second survey was also administered online from 1st October to 15th November 2022, resulting in 807 responses. The collected dataset was analysed using RStudio, and population weights were applied based on three demographic criteria (gender, age, and province) to ensure that the sample was representative of the Walloon population.

The findings of this study highlight the importance of public lighting in nocturnal mobility and provide insights into the factors influencing citizens' modal choices and acceptable levels of lighting reductions. Citizens are willing to accept reductions in public lighting levels during the night, which could contribute to reducing light pollution and energy

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consumption. The study also reveals a positive correlation between the energy crisis and citizens' willingness to accept reductions in public lighting levels, highlighting the importance of implementing energy-efficient public lighting systems.
Further research focuses on dark biodiversity corridors, and their compatibility with green corridors. We aim to work in accordance with SDGs 3, 11, 13, 14 and 15.

Towards developing business models for sustainable use of Small Medical Devices in healthcare

Mr Mohd Shoaib, Dr Antuela Tako
[1]Loughborough University

Parallel 1 - Sustainable Development Goals, Room 4.8, September 12, 2023, 09:15 - 10:45

Biography:
Mohd Shoaib is a Research Associate at the School of Business and Economics, Loughborough University. His research interests lie in the use of simulation modeling and optimization-based methodologies to comprehensively analyze and optimize system performance.

The National Health Service (NHS) contributes almost 4-5% of the total waste and gas emissions produced in the UK, of which nearly 10% comes from medical devices. The transition to a circular economy (CE) offers a viable solution to addressing the negative environmental implications associated with the current linear economic (make-use-dispose) model, mostly adopted in NHS and care settings today.
This research aims to assess the impact of modifications to the product design, materials, and recovery strategies of small medical devices (SMDs). This is the first research that takes a holistic system-wide approach to developing a proof-of-concept simulation model of the circular economy system that includes both the supply and recovery chain of SMDs. We assess the efficiency of these changes in terms of two key performance indicators: environmental (carbon dioxide emissions) and financial (costs) related to the production, use, waste management and recovery of SMDs. Four types of SMDs will be studied, fluid bags, inhalers, surgical tools, and glucose monitors.
In this presentation, we discuss different product recovery strategies and related decisions for refurbishment, materials recovery or reprocessing of an example SMD in a circular economy system design. We consider the challenges to developing simulation models of the circular economy of SMDs and to extracting relevant information from multiple stakeholders to inform these models. This work contributes towards the achievement of the wider United Nations Sustainable Development Goals for the reduction of the carbon footprint, more specifically to the Net Zero NHS strategy.

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Vehicle routing with stochastic demand, service and waiting times - a case of the food bank collection problem

Msc Meike Reusken[1], Gilbert Laporte[2], Sonja Rohmer[2], Frans Cruijssen[1]
[1]Tilburg University, Department of Econometrics and Operations Research, Zero Hunger Lab,
[2]CIRRELT and HEC Montreal

Parallel 2 - Sustainable Development Goals, Room 4.1, September 12, 2023, 13:15 - 14:45

Biography:
At Tilburg University I am part of the Zero Hunger Lab team, which aims to achieve global food security with data science. To convert my academic research finding into impact, I collaborate with the UN World Food Programme and the food banks in the Netherlands and Canada. These partnerships truly excite me. In addition to these applied studies, I enjoy to be involved in theoretical research.

Every one of my scientific projects has some connection to food security, optimization and uncertainty. Within this scope, I have worked on a very diverse set of operations research- and machine learning problems, including hidden convexity, stochastic vehicle routing, forecasting with tree based machine learning methods and humanitarian supply chain optimization.

In this paper we present a matheuristic for the capacitated vehicle routing problem with stochastic demand, service and waiting times. The problem and the considered uncertainties are inspired by the donation collection of food banks, where the donated amounts of food that need to be collected from a supplier only become known upon arrival and the time spent on waiting and service depends on the size of the donation. As these uncertainties also arise in many other practical settings, the problem can be generalised to a large variety of practical applications where uncertainty affects decision making. The resulting decision problem is highly complex and difficult to solve as a result of its stochastic nature and the various decisions involved. Therefore, the matheuristic presented in this research decomposes the problem into its individual decisions in order to find a solution to the problem. The matheuristic first decides on the number of districts into which the service area should be divided, while the second and third step focus on clustering the customers into these districts and planning the route for each district, respectively. Given to the stochasticity involved, the matheuristic enters an iterative procedure in case no feasible solution is found after execution of these steps. Depending on the degree of uncertainty, computational experiments demonstrate that the matheuristic can quickly and effectively solve problems sizes of up to 100 consumers. The research illustrates the practical value and applicability of the matheuristic by applying it to case studies using real data from Canadian and Dutch food banks.

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Budget allocation of food procurement and facility location for natural disaster response

Professor Stephan Onggo[1]
[1]University Of Southampton

Parallel 2 - Sustainable Development Goals, Room 4.1, September 12, 2023, 13:15 - 14:45

Biography:
I am a Professor of Business Analytics at Southampton Business School, the University of Southampton and a member of the Centre for Operational Research, Management Science and Information Systems (CORMSIS) and Centre for Healthcare Analytics. In my professional community, I am serving as an Associate Editor for the Journal of Simulation, a General Council member of The OR Society, and a community member of the INFORMS Simulation Society. Previously, I served as the chair of The OR Society's Special Interest Group in Simulation (2019-2022). My research interests include simulation modelling methodology and its applications in health care, disaster management and supply chain. My e-mail address is b.s.s.onggo@soton.ac.uk. My website is https://bsonggo.wordpress.com/

This talk is motivated by a real disaster management case in West Java Indonesia which has the highest multi-disaster risk in Indonesia. The region experienced an average of 4 disasters per day between 2016 and 2020, mostly small-to-medium scale disasters where the most common disasters were landslide, tornado, flood, and fire. Over 46 million people living in the 37,000 square kilometre (14,300 square miles) region. Hence, disasters such as floods often affect a significant number of people. Between 2016 and 2020, a total of more than 1.5 million victims were affected, with almost 100,000 of them had to live in shelters.

In this talk we will focus on two disaster management decisions faced by the regional disaster management agency. The first decision is how a fixed budget can be allocated efficiently over multiple time periods to procure large quantities of a staple food that will be stored and later delivered to people affected by disasters. Future demands, prices and availabilities are unknown at the start of the planning horizon, but data of past disaster exists that can be used to estimate probability distributions or simulate scenarios via resampling. We frame this as a variant of the lot sizing problem and experiment with different formulations to address the uncertainties (i.e. robust optimisation, risk-minimisation stochastic programming, and adjustable robust optimisation). The detail can be read from https://doi.org/10.1016/j.ejor.2023.05.015.

The second decision is how to position the warehouses considering that disasters can affect their capacity to deliver the food. Recent disasters such as the 2020 Beirut explosion and the 2023 Turkey-Syria earthquake have shown that facilities that are meant to help the victims

could be damaged by the disasters. Therefore, it is critical to increase the resiliency of critical facilities by dispersing their locations. We frame this problem as a stochastic capacitated dispersion problem where we maximize the minimum distance between any two facilities while satisfying a probabilistic constraint on the level of service. We propose a simheuristic algorithm to solve it and the experiment shows that it produces more robust solutions than the deterministic solution. This is still a work-in-progress.

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On the trade-offs between affordability, nutritional value and environmental impact of food baskets

Melissa Koenen[1], Claudia Damu[2], Marleen Balvert[1], Hein Fleuren
[1]Tilburg University - Zero Hunger Lab, [2]World Food Programme

Parallel 2 - Sustainable Development Goals, Room 4.1, September 12, 2023, 13:15 - 14:45

Biography:

Since 2019 Melissa Koenen works as a PhD student of the Zero Hunger Lab at Tilburg University, which uses data science to support NGOs in their mission towards sustainable development goal (SDG) 2: Zero Hunger. Her research is heavily intertwined with ENHANCE, a grand project that focuses on the optimization of food baskets such that they are affordable, nutritious and sustainable. By determining how sustainable various food baskets are, relevant planetary boundaries are taken into account. ENHANCE is a collaboration between the World Food Programme, Johns Hopkins University, Capgemini and the Zero Hunger Lab.

In general, Melissa loves to use her mathematical background within an applied setting, especially when it contributes to a better future. In her work she focuses on different aspects of a problem: from discussing the underlying practical problem with field experts to setting up the corresponding mathematical formulation and evaluating its implications.

Diet optimization is commonly used by humanitarian organizations such as the World Food Programme to get a cost estimate for a nutritious food basket in a certain region. This analysis helps them to identify local food barriers and to propose policies or programmes in order to improve the situation. Besides the affordability and nutritiousness of a food basket, there are many other goals that these baskets should aim to achieve. That is, an ideal food basket should be culturally appropriate, affordable, nutritious and environmentally friendly. In most cases it is not possible to achieve this, as goals can be conflicting. An environmentally friendly basket may not be culturally appropriate, or an affordable basket may not be nutritious and vice versa. In order to investigate how these different goals interact with each other we use multi-objective optimization to show all of these trade-offs. Because of its straightforward and well-explainable nature, a weighted sum sandwich algorithm is used to find the trade-offs by approximating the Pareto front with an inner- and outer approximation. By iteratively selecting the weight that minimizes the distance between the inner- and the outer approximation, the approximations are updated and the distance between them is minimized. In our research we specifically aim to 1) illustrate these trade-offs by means of clear visualizations; 2) show how these visualizations help to interpret trade-offs and 3) explain what kind of insights can be gained for informing policy and designing assistance or development programmes.

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Open SDG - an internationally lauded, open-source software, maintained by ONS to create a personalised SDG data reporting website

Dr Irina Erchova[1]
[1]Ons

Parallel 10 - Sustainable Development Goals, Room 4.1, September 14, 2023, 14:30 - 16:00

Biography:
Dr. Irina Erchova is GORS Methods, Data, and Research Analyst and the Head of Open SDG Platform Development in ONS.

The Office for National Statistics (ONS) gathers data and reports on individual SDG targets and indicators on the National Reporting Platform (NRP) for the United Kingdom (UK). The UK is a world leader in the coverage and quality of data - described as 'ground-breaking' by the United Nations Statistics Division.

In collaboration with the US, we have driven the development of Open SDG (https://open-sdg.org/), an open-source software to create and maintain SDG data reporting platform. Open SDG features allow to create customised multilingual reporting sites that are searchable, equipped with data filters, display charts and maps, and comply with international digital safety and accessibility guidelines. We also allow embedding content from other websites/applications, posting news and updates, automating reporting status update, and monitoring the web traffic.

During the presentation, I will briefly introduce ONS, the UK's NRP, and how the ONS SDG team works. I will also include a brief demo of Open SDG and share case studies with solutions implemented and lessons learned.

We have worked with countries, regions, and cities to develop their own platforms. Bringing together data and metrics in one place adds the value to the data and makes data available for monitoring, exploration, and re-use during implementation of the SDGs.

Every reporting platform created using Open SDG provides a unique depository for data, ranging from the world regional hubs, national hubs across government and beyond, local authorities, organisations, and corporations. We, thus, facilitate transparent reporting into the delivery of the SDG projects across all different strata of society.

There are currently over 35 international users and an increasing demand among UK local authorities and organisations. The Open SDG is a real example of what collaboration can

achieve. The project results in a continual cycle of improvement and efficiency savings, as more countries, cities and regions adopt the platform, the additional improvements benefit the whole community of users.

The ONS team leads development and customer support for Open SDG. We regularly update software, and knowledge products that freely available. Our goal is to share best practice and SDG-related initiatives to improve SDG data collection and reporting.

Dynamic analysis of modern slavery, environmental degradation, and water-food-energy nexus with the lens of Panarchy theory

Dr Marzieh Samadi Foroushani[2], Dr Mahnaz Hosseinzadeh[1], Dr Amin Vafadarnikjoo[1]
[1]University of Sheffield, [2]University of Tehran

Parallel 10 - Sustainable Development Goals, Room 4.1, September 14, 2023, 14:30 - 16:00

Biography:

Mahnaz Hosseinzadeh is a Lecturer in Operations Management and Decision Sciences at Sheffield University Management School, University of Sheffield, United Kingdom.

Mahnaz holds a PhD in Operational Research from the University of Tehran.

Prior to joining the Management School, Mahnaz worked at the University of Tehran, initially as a Lecturer and then a Senior Lecturer in Operational Research Management. She has also been a visiting researcher at Linköping University.

Her research focuses mainly on system dynamics, optimisation, multiple criteria decision making and soft operational research, emphasising social sustainability in supply chains.

Modern slavery is a human tragedy and includes various forms of exploitation, such as human trafficking, forced labour, and the worst forms of child labour. According to the latest estimates, around 50 million people worldwide are victims of modern slavery, over 28 million of whom are exploited as forced labourers. While several overlapping socio-economic, political, cultural, and institutional risks shape vulnerability, they are increasingly evidenced to be made worse by climate change impacts and environmental degradation. On the one hand, environmental degradation and consequential climate change affect the residents' life significantly, resulting in their increased vulnerability and displacement, which, in turn, beget modern slavery. On the other hand, those in the situation of forced labour have a significant role in environmental degradation and carbon emissions.

Accordingly, there is a dynamic causal reciprocal nexus between modern slavery and environmental effects; however, this circular linkage has been ignored in policymaking, considering each as a separate issue. Moreover, at a lower level, climate change may affect the Water-Energy-Food (WEF) nexus, directly affecting peoples' living conditions and poverty, making them prone to be coerced. For instance, climate change may result in rainfall affecting the water and energy required for agriculture. Although the causal interface between climate change-environmental degradation-modern slavery is well-discussed in previous research, denoting it as a complex social-ecological system, the

literature lacks a comprehensive model representing the causal loop structure of this system.

Furthermore, how the WEF nexus moderates the relationships between climate change-environmental degradation-modern slavery is rarely discussed in earlier studies. To improve a complex system, we first need to identify the non-linear causal loop structure and inherent delay regarding the various time scales of the system's variables. Accordingly, we aim to address this gap by developing a System Dynamics formulation of the climate change-environmental degradation-WEF-modern slavery system. We adopt the panarchy theory and the dancing the supply chain metaphor (Wieland, 2021) to structure the system of causal loop relationships among modern slavery mitigation strategies in supply chains (supply chain level), governance structure, and public strategies (political-economic level), and environmental degradation and climate change (planetary level).

Systems Thinking

What is Systems Thinking?

Mr Gerald Midgley[1], Dr Rachel Lilley[1]
[1]University of Hull

Parallel 1 - Systems Thinking, Room 5.1, September 12, 2023, 09:15 - 10:45

Biography:

Gerald Midgley is Professor of Systems Thinking in the Centre for Systems Studies, Faculty of Business, Law and Politics, University of Hull, UK. He also holds Visiting or Adjunct Professorships at Linnaeus University, Sweden; the University of Queensland, Australia; and Mälardalen University, Sweden. He has held research leadership roles in both academia and government, having spent twelve years as Director of the Centre for Systems Studies at Hull, and seven years as a Senior Science Leader in the Institute for Environmental Science and Research (ESR), New Zealand. Gerald has written over 300 papers for academics and practitioners on systems thinking and community operational research, and has been involved in a wide variety of public sector, community development, health service, technology foresight and resource management projects. He was the 2013/14 President of the International Society for the Systems Sciences, and has written or edited twelve books. These include: Systemic Intervention: Philosophy, Methodology, and Practice (Kluwer, 2000); Systems Thinking, Volumes I-IV (Sage, 2003); Community Operational Research: OR and Systems Thinking for Community Development (Kluwer, 2004); Forensic DNA Evidence on Trial: Science and Uncertainty in the Courtroom (Emergent, 2011); and the Routledge Handbook of Systems Thinking (Routledge, 2023, in press).

There are many different systems theories, methodologies and methods. Also, there are multiple systems communities developing their own specialist ideas on what systems thinking is. What would emerge if we were to facilitate learning across these communities? This is a 90-minute, participative workshop to support mutual learning. Starting in pairs, you will combine your thoughts to produce a definition of systems thinking, noting in discussion between you what matters most in the formulation of this. Also, you will note any ideas that you really wanted to be included, but couldn't be agreed between you. The 'couldn't be agreed' ideas will be written on flip charts alongside the definition. Then two pairs will come together in a group of four to repeat the process. Next, two groups of four will merge, and the process will continue until everybody in the room is in discussion together. The output will be an emergent definition and other ideas that are worth working on from particular perspectives in the room. The final discussion will be a reflection on what was prioritised in

the emergent definition and why, plus a revisiting of a few of the most valuable ideas that people still think need to be taken forward for the future.

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Managing Large Scale Systems Change in Outrageous Times

Dr Angela Wilkinson[1]
[1]World Energy Council

Parallel 2 - Systems Thinking KEYNOTE: Angela Wilkinson, Room 5.1, September 12, 2023, 13:15 - 14:45

Biography:

Angela Wilkinson is the 6th Secretary General and CEO of the World Energy Council, a diverse community network of over 3,000 member organisations that has been instrumental in promoting better energy developments in over 100 countries for nearly 100 years.

Dr Wilkinson has led the Council since 2019 as it defines, enables and accelerates successful energy transitions through its unique network, practical insights and leadership dialogues. She has over 35 years of experience in leading national and international multi-stakeholder transformation initiatives on a wide range of global energy, climate and sustainable development related challenges.

Previous roles include Board-level and senior executive responsibilities in the public-, private-, academic- and civic-sectors. She is also a published author.

This Systems Thinking Stream Keynote offers an opportunity to reflect on what is involved in managing large scale systems change in highly emotional, outrageous times. The mission of the World Energy Council is "to promote the sustainable supply and use of energy for the greatest benefit of all people". Getting from where we are today to a world of sustainable energy production and use cannot be achieved without systems thinking, as so many interconnected issues and stakeholder perspectives are involved. Angela Wilkinson, Secretary General of the World Energy Council, will describe how her organisation works with principles of realistic hope and sets out to create integrated policy frameworks. In particular, the systems thinking in the Council embraces:

- 'Discordant collaboration', given the inevitability of values in conflict,
- Navigation over time to a safe operating space, as the complexity of the global energy system will inevitably defeat attempts at 'all in one go' solutions,
- The acceleration of decarbonisation with justice and inclusion in mind, as policies that further embed or intensify social injustices will simply not be accepted by many of the people, organisations and nations who need to act on them, and
- Seeing things in terms of 'energy transition ecosystems', or new enclaves of action, so local perspectives and critical interdependencies can both be accounted for at a manageable scale. Examples from the work of the Council across the globe will be provided.

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Systems Thinking for Equity-Focused Community Collaborations

Kirsten Kainz[1], Emma Kainz
[1]Just Learning Systems

Parallel 2 - Systems Thinking KEYNOTE: Angela Wilkinson, Room 5.1, September 12, 2023, 13:15 - 14:45

Biography:
Kirsten Kainz, founder and principal consultant at Just Learning Systems, is an engaged methodologist who specializes in group processes for evaluation and learning. She has worked for over 25 years in higher education serving in research, teaching, and leadership roles. She has published, taught, and presented about how people work together to learn about their current conditions, envision desired changes, and create pathways to new and better outcomes. As a consultant Kainz practices sensemaking with groups to identify their purpose, understand their environments, express their values, and achieve their goals.

Equity-focused community collaborations represent a unique opportunity to introduce and foster systems thinking to make sense of and address longstanding social inequities related to health, education, and economic resources. Such collaborations often involve diverse interested parties attempting to align and coordinate understanding and action to address a focal inequity (e.g., school achievement, safe housing). Woven into the alignment and coordination efforts are varied understandings of the focal inequity, its location in a system of entangled inequities, as well as varied awarenesses of the histories, relationships, incentives, logics, and resource allocations that hold the inequity in place. Systems thinking and critical systems approaches have demonstrated promise for engaging diverse interested parties in sensemaking and action related to social inequities. Given the multiple definitions and approaches to systems thinking available in the published literature collaboration facilitators will likely engage in decision making and boundary setting when selecting and introducing systems thinking resources for community collaborations. This presentation will provide a reflection on experiences selecting and introducing systems thinking resources in communities with the intent of fostering reactions and conversation among participants at OR 65.

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Rethinking Self-Reflection in Systems Practice

Dr Rachel Lilley[1], Mr Gerald Midgley[1]
[1]University of Birmingham

Parallel 3 - Systems Thinking, Room 5.1, September 12, 2023, 14:45 - 15:45

Biography:

Dr Rachel Lilley is a Senior Fellow at the Birmingham Leadership Institute, a new teaching and research centre in the University of Birmingham focusing on systems leadership. She is a practitioner-researcher in systems approaches and systems leadership, and also Programme Director for an innovative transdisciplinary Masters Programme bringing together Systems Leadership and Systems Practice.

Rachel's high impact research looks at human decision-making, systems thinking capabilities and behavioural change. It has supported policy design and practice, community initiatives and leadership development at all levels. She has a particular interest in building capability to address climate and social change.

Rachel is an expert in human sense-making, with specialist knowledge in cognition, consciousness and perception. Her theoretical expertise is supported and informed by a track record in practicing, teaching and developing embodied perception skills in teams, organisations and individuals. She has over 30 years of experience working with large corporates, public sector and third sector organisations as a systems practitioner, covering community engagement, social issues, climate change, leadership and wellbeing.

For more information visit her websites:

https://predictingmind.com

https://www.birmingham.ac.uk/staff/profiles/bli/lilley-rachel.aspx

The transdisciplinary field of Systems Thinking has paid a great deal of attention to the meaning of the word 'systems': we have used the systems idea to better understand complex organizational, social and ecological problems; and to tackle those problems, we have designed various systems methodologies, models, innovations, and leadership practices. However, we have paid much less attention to what constitutes 'thinking', or cognition. Systems theories of cognition, originally advanced in the 1980s, have been validated, further developed and considerably enhanced by forty years of cognitive and neuroscientific research. Appreciating the implications of this research can transform our

understanding of self-reflection as part of systems thinking. This presentation will first explain two aspects of the science: the anticipatory (or predictive) nature of cognition, and the idea that emotion is an integral part of that cognition, not something that gets in the way of it. It will then look at the implications for self-reflection in systems practice, which is essentially about spotting the expectations we bring from past experience so we open up new avenues for choice about our interactions with others in the flow of practice.

Why governments need system scientists

Dr Shann Turnbull[1], Senior Scientist Yiannis Laouris[2]
[1]International Institute for Self-governance, [2]Future Worlds Center - Cyprus Neuroscience & Technology Institute

Parallel 3 - Systems Thinking 2, Room 4.16, September 12, 2023, 14:45 - 15:45

Biography:
Shann Turnbull graduated as an electrical engineer in Tasmanian and with a Batchelor of Science in physics and mathematics at the University of Melbourne. After completing a Harvard MBA, he became a serial entrepreneur establishing a flying school, a film finance business, two public mutual funds, and three other enterprises that became publicly traded. He was a co-founding member of a private equity group that in its first four years acquired control of fourteen publicly traded firms. He co-founded the first educational qualification for company directors in the world in 1975 and wrote Democratising the Wealth of Nations launched by the Deputy Prime Minister of Australia. As a result of his book, he was invited to Prague in 1990 & 1991 and to Beijing in 1991 to advise on stakeholder privatization. His Ph.D. research introduced bytes as the unit of analysis to establish the science of governance to investigate self-regulation and self-governance of any specie. Transaction Byte Analysis explains why biota uses a requisite variety of distributed decision-making to simplify complexity. Also, to create tensegrity required to achieve self-regulation and self-governance but capable of adaption and evolution. Google reveals he is a prolific author on reforming the practices of capitalism based on biomimicry.

Governments need system scientists as they understand how complex problems can be simplified, and how control of complexity can be amplified, to avoid many existential risks to humanity. System scientists have proved they know how to design self-governing automobiles and spacecraft. All living things illustrate self-regulation and self-governance to survive until they can reproduce in unknowable dynamic complex environments. How humans achieved the same was identified in the 2009 Nobel Prize acceptance speech of Elinor Ostrom. System scientists understand how the Ostrom design rules are consistent with the natural laws that govern biota. All biota, including humans, achieve self-regulation and self-governance without a Chief Executive Officer neuron. Human minds illustrate how complexity is simplified by decision-making being distributed to many regions. These compete for relevance according to our internal needs and drives and external risks and opportunities. Ostrom described this as “Polycentric” self-governance. System scientists described it as following the natural law of requisite variety. The competitiveness and resilience of polycentric governed firms that have survived and thrived during several business cycles are illustrated by bottom-up stakeholder-governed firms around the world. Also, by sporting organizations. System scientists can explain to governments how tax

incentives could be used to convert organizations to become self-governing agents to provide benefits for all their stakeholders. This was the 2019 objective of the US Business Round Table. Organizations that provide such benefits would then become agents for governments to simplify the complexity of managing key existential risks to humanity on a self-reliant, self-regulating, and self-governing basis. Corporate agents providing benefits could amplify control of complex problems like climate change. They could directly assess the 8 billion people on the planet to take their feet of accelerators that the UN Secretary-General said are “driving us to a climate hell”.

"Don't You (Forget About Me)"

Dr Miles Weaver[1], Dr Hock Tan, Dr Anna Fonseca
[1]Edinburgh Napier University

Parallel 3 - Systems Thinking 2, Room 4.16, September 12, 2023, 14:45 - 15:45

Biography:
Miles is an Associate Professor at Edinburgh Napier University Business School. His work focuses on bringing together systems thinking for sustainability. Particularly, to advance the acceleration of progressing the Sustainable Development Goals in place-based cross sector collaborations.

Inspired by the King's Coronation concert, one could only be captivated by the nature-themed section, shining a spotlight on Mother Earth and the 'pressing need for change.' This change is articulated in the seventeen Sustainable Development Goals (SDGs) as a shared blueprint for peace and prosperity, for people and planet, now and into the future (UN SDGs, 2023). The UN recognise that for the goals to be realised, climate change and work to preserve our oceans and forests needs to be tackled (UN SDGs, 2023). A reminder that amongst this deep interconnectivity we must not forget that everything we do is grounded in the fragile world around us (Berners-Lee, 2021). The concert segment concluded with a rendition of a 1980s hit, which has influenced this paper's title and theme.

Systems thinking and Community OR (COR) have a significant role to play in addressing these sustainability grand challenges. The UN, OECD, UNESCO and WHO and many major organisations across different sectors have declared systems thinking as an essential leadership skill (Jackson, 2019). As Jackson (2019) points out ideas such as complexity, multiple causality, interconnectedness, wholeness, seeing things differently are all synonymous with systems thinking. Plus, COR is concerned with a meaningful engagement of communities (Midgley, Johnson and Chichirau, 2018). We consider this definition considering 'place-making' and a transition from 'ego to eco' thinking (akin to the views of Lent & Capra, 2017 and Sharmer (2018) etc.,). Like the rise of 'emancipatory' systems approaches to address 'coercive' problem contexts, a change in thinking to bring about truly regenerative ecosystems that recognise our co-existence in partnership with the living systems of our environment is advocated.

This paper proposes four critical boundaries of interest: purpose (values and interests); Interdependence (planetary pressures, societal foundation) and transition (pace and place). Taken from two modes of analysis: 1) the business model and its wider impact and 2) engaging communities in partnership working for the goals. Reflecting on these critical boundaries alongside other systems thinking approaches will help ground business models

and cross-sector collaborations towards a just and safe space for humanity as depicted by Raworth (2017).

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Towards a New Framework for Methodological Pluralism

Mr Gerald Midgley[1], Dr Rachel Lilley[1]
[1]University of Hull

Parallel 3 - Systems Thinking, Room 5.1, September 12, 2023, 14:45 - 15:45

Biography:

Gerald Midgley is Professor of Systems Thinking in the Centre for Systems Studies, Faculty of Business, Law and Politics, University of Hull, UK. He also holds Visiting or Adjunct Professorships at Linnaeus University, Sweden; the University of Queensland, Australia; and Mälardalen University, Sweden. He has held research leadership roles in both academia and government, having spent twelve years as Director of the Centre for Systems Studies at Hull, and seven years as a Senior Science Leader in the Institute for Environmental Science and Research (ESR), New Zealand. Gerald has written over 300 papers for academics and practitioners on systems thinking and community operational research, and has been involved in a wide variety of public sector, community development, health service, technology foresight and resource management projects. He was the 2013/14 President of the International Society for the Systems Sciences, and has written or edited twelve books. These include: Systemic Intervention: Philosophy, Methodology, and Practice (Kluwer, 2000); Systems Thinking, Volumes I-IV (Sage, 2003); Community Operational Research: OR and Systems Thinking for Community Development (Kluwer, 2004); Forensic DNA Evidence on Trial: Science and Uncertainty in the Courtroom (Emergent, 2011); and the Routledge Handbook of Systems Thinking (Routledge, 2023, in press).

Since the mid-1980s, the systems thinking and OR communities have been writing about and practicing methodological pluralism (sometimes called 'multimethodology' in the OR literature). We have been celebrating methodological diversity, and this has created a rich resource for practice, but there has been an unfortunate side-effect: there is now so much diversity that it is hard to tell a newcomer to systems thinking what it is while still staying faithful to the breadth and depth of the methodological ideas in our research community. We need a simple narrative of systems thinking that is easily communicated, but doesn't undermine methodological pluralism. A new framework for methodological pluralism will be presented. A simple story of systems thinking is at its heart, and this helps to organize the methodological diversity into a 'landscape' of systems practice. This allows newcomers to our field to understand some basic systems thinking skills and then, if they wish, appreciate the complementarity of a variety of methodologies that enhance the application of those skills for specialist purposes.

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Systemic Intervention in Chinese Context: The Case of Double Reduction Policy

Ms. Kristin Wanyi Yao[1], Dr. Charles Leung[1]
[1]Beijing Normal University-Hong Kong Baptist University United International College (BNU-HKBU UIC)

Parallel 4 - Systems Thinking, Room 5.1, September 13, 2023, 09:00 - 10:30

Biography:
Ms. Kristin Wanyi Yao is a senior undergraduate at a university in China that uses English as the medium of instruction. She is pursuing a degree in Social Work and Social Administration and presented a case study on social work practice at a national conference on social work education in 2022., Moreover, Kristin has worked with various non-governmental organizations and foundations dedicated to social development issues. Notably, she held the role of Director-General for a non-profit organization formed by a group of university students. The organization aimed to promote quality education in rural China. Under her stewardship, the program gained accreditation in a public service recognition meeting held in the Guangdong-Hong Kong-Macao Greater Bay Area. As of May 2023, Kristin received over ten national and provincial accolades in youth venture philanthropy and social innovation. Her research interests include project management and evaluation, social service design and intervention, focusing on children and adolescents, gerontological social work, and hospice care.

This paper depicts how we could utilise systems thinking and its application in real-world settings of social work practice through the concept of 'boundary critique' with a Sinosphere perspective. The process we propose can analyse and facilitate intervention design for complex situations where there are conflicting understandings of social work values such as social justice, equality and equity. Drawing on the case of China's "Double Reduction Policy" (DRP), we argue that the indigenous application of boundary critique can help identify and address the underlying assumptions and power dynamics that contribute to these conflicts. In 2021, the Chinese government announced the DRP, a policy aims at reducing the excessive study burden on students, shifting the focus away from examination-oriented practices and improving the overall quality of education. However, stakeholders such as students, parents, teachers, school administrators, and leaders in the local private tutoring industry raised various concerns and puzzles.

We review official records and case examples from the literature as well as our own fieldwork experiences, demonstrating the process to navigate conflicts among stakeholders and develop implementation plans with their support. By examining the value judgments of stakeholders (including ourselves) across a continuum of conscious levels, we can articulate

the underlying causes of ethical conflicts and design interventions that address these root causes.
Specifically, we illustrate the application of the 'Tai Chi' concept in articulating the various DRP stakeholder perspectives, highlighting the importance of considering these distinct, neglected, and hidden standpoints. We also discuss the limitations of utilising this Chinese understanding of systems thinking in practice and suggest ways to address these challenges. Overall, this paper contributes to the growing literature on systems thinking and social work practice by demonstrating how boundary critique can be used to address complex and conflicting understandings of actualising ethical values in the Chinese context. We argue that this approach has important implications for promoting social justice and human rights in China and other similar contexts where diverse perspectives on these values coexist.

Large-scale Brain Networks and Complex Problem Solving Enhanced by using Metaphor and Guided Relaxation

Mr Mike Parker[2]
[1]Liminal Coaching Limited, [2]Schumacher Institute

Parallel 5 - Systems Thinking, Room 5.1, September 13, 2023, 10:50 - 12:20

Biography:

Mike Parker is the Founder of Liminal Coaching and developed the technique that gave the company its name.

He has over 30 years of experience helping clients innovate, overcome challenges, and improve performance across a wide range of personal and professional domains.

Mike's interests are deep and broad, ranging across psychology, anthropology, philosophy, math, business, music, economics, culture, and systems thinking. He has an MBA in innovation, finance and strategy and has supplemented this with further postgraduate studies in Systems Thinking and Governance.

He is a qualified Solutions Focused Therapist and a Research Fellow at the Schumacher Institute, an independent think tank dedicated to solving complex social, economic and environmental crises.

This session will review recent research showing the significance of brain states where the Default Mode Network is activated for the creative generation of solutions to complex problems.

"The default mode network (sometimes simply called the default network) refers to an interconnected group of brain structures that are hypothesized to be part of a functional system. The default network is a relatively recent concept, and because of this there is not a complete consensus on which brain regions should be included in a definition of it. Regardless, structures that are generally considered part of the default mode network include the medial prefrontal cortex, posterior cingulate cortex, and the inferior parietal lobule" Marc Dingman Ph.D.

I will cover a variety of claims being made about the function of the DMN, showing that this is still a rapidly developing area of research.

However, the linking of the DMN and other large-scale brain networks to creativity in recent research ties in with psychological studies on mind wandering (daydreaming) and creative solution development.

I will describe the use of guided relaxation and metaphoric scenarios constructed to activate and focus the DMN and other networks involved in creative insight. In the past year, this has been successfully used with the exec team of a large New York PR company prior to their annual strategy day workshops and a large UK government agency to kick off its exploration of the application of Systems Thinking to solving complex problems.

There should be time for Q&A at the end.

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Systems Thinking to address the complexity of fragmentation-in-care: The case of malnutrition management in the Indian context

Dr Deepa Austin[1]
[1]International Institute of Information Technology, Bangalore, India

Parallel 4 - Systems Thinking, Room 5.1, September 13, 2023, 09:00 - 10:30

Biography:

Dr. Deepa Austin is a public health professional with research interests in areas of systems thinking, digital health, ICT designs, health informatics, integrating care delivery systems and administrative skills in Hospital sector with Masters in Public Health Dentistry and Masters in Hospital administration. Her quest to understand the applications of digital systems in complex public health settings motivated her to pursue Ph.D at E Health Research Centre, International Institute of Information Technology, Bangalore (from 2018) and is currently associated with a project on ICT enabled malnutrition management for the state of Karnataka. She has been instrumental in designing ICT applications relevant to address complex public health problems, by conducting disciplined contextual studies and user research, analysing relevant needs of the stakeholders, negotiating with stakeholders' interests working towards creating user-centric designs and facilitating ICT adoption and usage. She has a wealth of experience in dentistry and has served as clinical dentists for over thirteen years and five years into teaching. She has served as teaching faculty in department of Prosthodontics at Mar Baselius Dental college, Kerala and as faculty for Marian Institute of Healthcare Management, XLRI, Goa, Management Academy and Research Centre, Bangalore. She has taught management subjects like organizational change, change management, organization and management of Hospitals. She has also worked as accreditation coordinator and Manager-Public Relations at ISIS Medicare and research centre in Bangalore.

Deepa has developed an Indian Dietary Index on Quality Eating for Children, to provide a snap shot of the diet quality of Indian food pattern in conformance with the requirements of Indian dietary guidelines. The scores of this index can serve as predictors for many diseases and can be used for prevention and early intervention strategies. She has also contributed in the area of current control policies on tobacco use in India and cessation Programs.

While there is a lot of enthusiasm for the integration of ICTs into public health systems for timely and coordinated interventions, several recent research studies have shown that the promise of ICTs in the health domain is still mostly unrealized. It seems that one of the most likely causes of the differing convergence of digital and public health systems is the failure to address the inherent complexity aspects of public health systems. Inadequate consideration of the heterogeneity of local contexts and practices, underrepresented perspectives of diverse stakeholders, and the inability of technology designs to adapt to

dynamic and non-linear behaviors have all been cited as reasons. It is crucial to understand that public health issues like malnutrition management are complex and woven into the fabric of extant social structures and practices. Lack of acknowledgment of this interconnectedness can result in “fragmentation-in-care”, one of the principal shortcomings of the contemporary health systems

A key constraint in understanding the complexity is the absence of a well-defined methodology that can help unfold the multitude of its characteristics. Using the case study on ICT-enabled tracking and managing malnutrition in Karnataka, India, my research works aims to understand how common practices in embedded contexts can be used to explore the complexity characteristics of public health systems. The study methodology was informed by the systems thinking in practice approach and participatory action research to gain a detailed understanding of the complexities in community and facility-based malnutrition management in Karnataka. The findings were then carefully fed to design and strategize iterative and incremental ICT-enabled action plans. Different versions of the ICT-based application were designed in an episodic manner to address the fragmentation-in-care in malnutrition management, which is successfully functional across nutritional rehabilitation centers of Karnataka.

Accepting that change is inevitable and that the systems are unpredictable could mean that public health information systems would benefit greatly from boosting their agility through self-organizing capabilities. This research offers insights into the advantages of adopting the holistic lens of systems thinking that helped to attend progressively towards offering the most desirable and feasible solutions to navigate through complexity.

L7 Systems Thinking Practitioner Apprenticeship

Miss Helen Sanson[1], Mr Dan Amin
[1]Forcera and Advance HE

Parallel 4 - Systems Thinking, Room 5.1, September 13, 2023, 09:00 - 10:30

Biography:
Dan Amin is the Quality and End-point Assessment Manager for Advance HE, the first recognised End-Point Assessment Organisation for the L7 Systems Thinking Practitioner Apprenticeship. Helen is the Director of Forcera and one of three consultants that worked with Dan to create the handbook for the apprenticeship.

Helen and Dan will talk about how Systems Thinking was used to decipher the L7 Systems Thinking Practitioner apprenticeship standard. This then raises the question: can Systems Thinking become a standardised occupation in the tradition of the apprenticeship? We will have contributions from some of the apprenticeship providers who will discuss what Systems Thinking Practice means to them.

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Developing systems thinking and systems leadership for senior leaders within government: How awareness of systems thinking builds capability for members of the senior civil service.

Mr Ben Spurway[2], Mrs Andrea White[1], Dr Ben Follows[1], Mary McKee[3], Katie Gronow[3], Rachel Bennett[3], Adam Mackenzie-Jones[4]
[1]HM Revenue & Customs, [2]Leadership College for Government, [3]Department for Transport, [4]Department for Energy Security & Net Zero

Parallel 5 - Systems Thinking, Room 5.1, September 13, 2023, 10:50 - 12:20

Biography:

Ben's focus is on developing leadership capability across HMG. He currently leads the Cabinet Office's Leadership College for Government team responsible for the new Senior Civil Services Induction Programmes. He previously led the Civil Services Deputy Director and Director Leadership Programmes and represented the Dept of International Trade's Export and Investment professionals in a cross-HM

Government team developing the new International Trade Profession.

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Andrea is a senior OR leader in government. She has worked in a number of analytical roles across DfE, Cabinet Office and HMRC, with over 20 years' experience working within the Government Operational Research Service (GORS). Since April 21 she has been heading up the Operations, Strategy and Transformation team in KAI, the analytical directorate in HMRC. She has worked in analytical roles, supporting policy development, setting direction for compliance strategy through building evidence, developing performance frameworks, leading economic analysis for the covid taskforce and currently leading on analytical support for transformation within HMRC. Through this, Andrea has used numerous operational research techniques to help colleagues work through uncertainty and complexity to deliver policy and operational changes.

Link to GORS: http://www.operational-research.gov.uk/recruitment

Prior to joining the Civil Service in 2017 Ben was Head of Learning & Development at ZipCar, part of the Avis-Budget Group. Ben has previously held senior capability development roles and teaching positions in the Higher Education, Humanitarian Crisis Response, and Outdoor/Adventure Education sectors. A common theme to all these roles is operational research although Ben does not claim to be an Operational Researcher.

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Complex problems cut across organisational and professional boundaries. Solving them requires thoughtful, ego-free collective leadership to deliver on the promise of government priorities like Net Zero, Levelling Up and Global Britain. Rather than focus on specific leadership traits, the Leadership College for Government's Senior Civil Service Induction programme has worked with Operational Researchers to emphasise the conditions necessary for systems change. New leaders are introduced to the core capabilities of being able to see the larger system of which they are a part, fostering more reflection and generative conversations, and shifting the collective focus from reactive problem-solving to co-creating the future. Twelve months on, the team reflect on lessons and impact of the programme on systems leadership capability and delivery.

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Finding common ground or harmonising the incommensurable? A critical reflection on integrating diverse systems thinking approaches through exploring the nature of mind and its foundational role in the act of structuring reality.

Dr Harley Pope[1]
[1]Walker Institute

Parallel 5 - Systems Thinking, Room 5.1, September 13, 2023, 10:50 - 12:20

Biography:

Dr Harley Pope is an interdisciplinary research fellow with an educational background in biochemistry, ecological management, science and technology studies, and international development. Over the course of his academic career he has focused on investigating and teaching cross-cutting sustainability issues with food, development and the environment as their nexus. He is passionate about helping people better understand how to think about complex systems and visualise pathways to alternative sustainable futures in engaging ways.

Prior to joining the Walker Institute Harley developed and led the European Food Systems Education and Training (EFSET) programme – a pan-European, interdisciplinary food systems postgraduate education course. He maintains an active interest in developing systems pedagogy and finding effective ways of fostering systems literacy in a variety of contexts.

Having joined the Walker Institute as a research fellow and Walker Academy Lead, Dr Pope is responsible for running, developing and enhancing Walker's current portfolio of educational courses. He also provides social science expertise to the activities of the institute across a number of research projects.

At the heart of all systems thinking is a desire to grapple with the complex, interdependent and holistic nature of phenomena in meaningful and practical ways. Although there have been three major waves of systems thinking, there has been no definitive paradigm shift that has completely unseated a previous incumbent. Each wave has evolved over time, responding to, and to some extent incorporating, the critiques from the wider systems thinking community, but which still exists with their own communities of practice. This poses problems to practitioners wishing to apply approaches from different waves due in part to the potential for 'paradigm incommensurability' – the incompatibility of fundamental philosophical assumptions that underlie the different paradigms and their methods. Arguably, a desire for integration and harmonisation across systems approaches, which, coupled with the ongoing need for utilitarian and efficacious systems methods

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required to address the challenges of the Anthropocene, is driving the emergence of a fourth wave.

This paper seeks to contribute to the development of this nascent fourth wave by evaluating the ways in which the different waves can be harmonised through actively reflecting on the nature of mind and the thinking process as it applies to the act of systems thinking.

Building on insights from contemplative traditions, neuroscience, and holistic science, it will demonstrate how the emergence of individual and group conceptualisations of system structure, function and purpose, are partially and selectively representative of reality, but still inter-related to each other. It will propose a phenomenological, contemplative, and reflective approach to thinking about systems that can allow a practitioner to navigate and transcend paradigmatic differences.

Finally, it will draw out the implications of this approach for systems pedagogy and the development of a systems literacy to aid practitioners develop and enhance their own systems thinking capabilities.

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A systems approach to economics

Prof Andrew Basden[1]
[1]RIdg

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
After retiring from a career in both academia and 'business, which covered expert systems, information systems, business systems, human factors, philosophy, theology and environmental sustainability, Andrew Basden now convenes the Reith Lectures Discussion Group, a global online discussion, which is developing a new approach to and understanding of economics, with the help of Dooyeweerd's philosophy and Christian and other religious perspectives.

Towards a Systems Approach to Economics

ABSTRACT

With the credit crises, environmental crises, covid crisis and conflicts, the whole of economics - both practice and theory - seems to be in crisis. Many are the new ideas emerging about how to address these, ranging from Doughnut Economics, Relational Economics, Foundational Economics, Post-Growth Economics, Environmental Economics, Mission Economics, and so on, some elaborating older ideas like the Circular Economy and Schumacher's Small is Beautiful. Yet mainstream economists and those who use economics (politicians, pundits, etc.) fail to take them on board. Why?

Economics does not reflect enough on its place among other spheres of life. Economics does not know how to take full account of value beyond its sphere, such as of environment. Economics does not have a strong enough understanding of functioning and repercussions, both human and non-human. Economics does not adequately differentiate harmful and useless from good economic activity. Economics puts too much emphasis on entities instead of the Good that we are called to do, resulting in fragmentation, envy and greed.

What we need is a systems approach in both theory and practice. Rather than addressing each of the problems discussed separately, we need a way to understand economics in its entirety.

Stimulated by Mark Carney's 2020 Reith Lectures on Value(s) in economics, the RLDG (Reith lectures Discussion Group) was convened to discuss them and take them further. From 23 discussions, a fundamental reframing of economics has emerged that, with the help of

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philosophical and Christian and other religious perspectives, a fundamentally new understanding of economics has emerged that is useful to practice as well as theory.

It begins with the meaning and mandate of economics, and the importance of mindset and attitude. It offers a systematic way to bring disperate values together, and of understanding diverse functioning and repercussions, both human and non-human, and clearly differentiate good, harmful and useless economic activity. To reduce fragmentation, it reconceives the entities in economics, and their subject-object relationship (such as stakeholders, individuals, households, nations and the global economy with money and resources) in terms of their contribution to Overall Good.

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Using Systems Thinking to Improve Operations: The Case of a Design and Manufacturing Firm

Miss Shahd Zabeery[1], Dr Krishna Balthu[2], Dr Geoff Parkes[3], Dr Brian Price[4]
[1]Aston University, [2]Aston University, [3]Aston University, [4]Aston University

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Miss Shahd Zabeery is a Knowledge Transfer Partnership (KTP) associate at Aston University Business School, based at the premises of the company partner as a Business Transformation Analyst. She completed her BSc at Swansea University in Chemical Engineering and after graduating, gained some experience as a field engineer in an oil and gas service company in Saudi Arabia. She then completed an MSc in Engineering Management at Aston University. Her dissertation topic was on the effectiveness of Change Management in the oil and gas industry during COVID-19. Her interest was then to seek a role within operations and change management, encouraging her to pursue the KTP role. Shahd is keen to continue developing her knowledge and experience in the operations field.

Implementing strategic change is one of the most important undertakings of an organisation (Sonenshein, 2010). However, more than 70% of the change initiatives fail and even the largest and most successful organisations have stumbled at achieving change (Nohria & Beer, 2000).

In this poster we will present the case of a design and manufacturing firm based in the UK, which joined forces with a University to undertake a strategic change programme aimed at improving operations and imparting a competitive advantage to the firm in their niche sector of visual merchandise.

A novel systems thinking approach called Process Oriented Holonic (PrOH) Modelling Methodology has been used to structure the intervention for change. Using PrOH Modelling in a broader Action Research framework, we were able to engage staff within all the departments in the organisation e.g., Sales, Design, Production, Assembly and Installation. Action research can be described as a cyclical process where the researcher primarily selects a real world situation, assigns respective roles to the people (participants) in that situation and begin to inquire about the situation so as to make improvements (Susman and Evered, 1978; Checkland, 1991).

This research presents how PrOH Modelling facilitated collection of process data followed by analysis and development of Human Activity Systems models which captured the complexities in delivering products and services to clients in the consumer electronics

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industry. The poster highlights the merits of applying a soft systems based approach to elicit operational issues, followed by implementation of practical changes. By working in conjunction with design and production staff, several key changes have been implemented such as the following:

- Developed a typology based on value and type of the project.
- Identified communication barriers within project teams and developed a system to improve it.
- Implemented a stage gates approach to improve process flows.

References:

*A full list of references will be presented in the poster.

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Comparing Emotional and Structural Boundaries: A case study of sustainable urban development in London

Ke (Koko) Zhou[1], Dr. Irene Pluchinotta[1], Mr Pouria Paridar[1], Dr Nici Zimmermann[1]
[1]University College London

Parallel 8 - Systems Thinking 1, Room 3.5, September 14, 2023, 09:00 - 10:30

Biography:
Koko Zhou is a research fellow at the Bartlett's Institute for Environmental Design and Engineering, University College London (UK). Her area of expertise is system dynamics modelling and systems thinking. She focuses on organizational decision-making and resilience in managing sustainability and health challenges.

Critical systems thinking highlights that conflicts in people's values and boundary judgments can marginalize certain parts of a system. While researchers have acknowledged the role of emotions in shaping values, attitudes, and preferences in the decision-making process, emotional boundaries have yet to be analysed explicitly, compromising our understanding of systemic interventions that consider individual views, priorities and feelings. We contend that the comparisons of both structural boundaries (variables and interconnections) and emotional boundaries (variable-related feelings) between different stakeholder groups is crucial to foster reflective system thinking and awareness in systemic interventions. Through interviews in a London-based case study on water neutrality and sustainable urban development, we examined and compared structural boundaries using causal loop diagrams and emotional boundaries through sentiment analysis. We found that despite the shared goal of achieving sustainability in developments, stakeholders have various structural and emotional perceptions of the variables contributing to water neutrality and long-term sustainable growth. This paper illustrated how the emotional and structural boundaries both impact the dynamics of decision-making (marginalisation and centralisation of parts of the system) in the sustainable urban environment.

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Prediction and the use of causal loop modelling to identify the limits of systems thinking methods and define complex systems

Dr. Terence Love[1]
[1]Love Services Pty Ltd

Parallel 8 - Systems Thinking 2, Room 4.5, September 14, 2023, 09:00 - 10:30

Biography:
Terence has been involved in systems design, systems thinking and systems research since studying control systems and design optimisation via AI at Lancaster University. Recent systems research has been in the development of Variety Dynamics as a new systems field and new area of mathematics for managing and taking ownership and control of complex and hyper-complex systems; and identifying biological bounds relating to systems. Terence is also a professor of industrial design at a Middle Eastern university, with over 120 publications and provided research and training services to Federal, State and Local Government agencies, businesses and NGOs in Australia and internationally. In the last three years he has provided review services for over $3billion of built infrastructure.

This paper describes the use of causal loop diagrams to quickly identify which systems thinking methods can be validly used for specific problems. The paper also describes the inverse: whether a system situation can be validly addressed by a specific system thinking approach. The paper focuses on the role of prediction in systems thinking as a means of testing validity of application of system method to specific contexts. The paper builds on the earlier work of the author in identifying a human biological limitation of mental prediction at two feedback loops to extend this into a formal systems methodic and a proposed basis for defining complexity in a pragmatically practical and useful manner for system practitioners and researchers.

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The application of systems approach and systems thinking to address the Continuous Critical Challenges that humanity faces

Senior Scientist Yiannis Laouris[1], Dr Reynaldo Treviño-Cisneros, Mr Kevin Dye
[1]Future Worlds Center

Parallel 8 - Systems Thinking 3, Room 5.1, September 14, 2023, 09:00 - 10:30

Biography:
Leads internationally the theory and application of the science of structured dialogic design and conducts research towards developing systems to enable scaling up participatory dialogic processes to engage asynchronously thousands of people in meaningful authentic dialogues, thus accelerating institutional and societal change. Promotes the application of broadband technologies and structured democratic dialogue as tools to bridge the digital-, economic-, educational- and inter-personal divides in our planet. Social-, business-, and science entrepreneur; medical doctor, neuroscientist, educator, systems engineer, and IT expert. Lead scientist and Chair of Future Worlds Center. Founding member of several CSOs and high-tech companies, member of Board of Institute for 21st Century Agoras; national representative in several COST Actions, Insafe, Inhope, EU Kids online, ECSO, Cybercrime Centre of Excellence, ECTEG – Europol, and member of Boards and/or partner in several high-tech companies. One of the 12 authors of the ONLIFE Manifesto, and key author of Reinventing Democracy in the Digital Era Manifesto. Holds MD (distinction), PhD Neurophysiology (summa cum laude), MSc Eng (GPA 4.0), PhD Systems Engineering (pending). 80+ papers/book chapters; 160+ conference papers.

The Club of Rome identified 49 Continuous Critical Problems (CCPs) five decades ago, aiming to address complex challenges (Predicament of Mankind - Quest for Structured Responses to Growing World-wide Complexities and Uncertainties, 1970). Among these, the 49th problem highlighted "Insufficient understanding of Continuous Critical Problems, their nature, interactions, and future consequences from problems and their solutions." In the early 2000s, the United Nations established 8 Millennium Development Goals (MDGs; Millennium Development Goals, 2000) to combat poverty by 2015. Progress was made, but the poorest and most vulnerable were left behind, and targets were only partially met. In 2016, the UN adopted 17 Sustainable Development Goals (SDGs; The 2030 Agenda for Sustainable Development) to address poverty, inequality, injustice, and climate change by 2030. Despite recent initiatives identifying new challenges, the authors argue that the CCPs remain insufficiently addressed. Albert van Jaarsveld, Director General of the International Institute for Applied Systems Analysis, emphasizes a systems approach and thinking to understand the world. He stresses the need for governments to change their policy-making and implementation methods. The authors apply Interpretive Structural Modeling (ISM: Warfield, 1974, 1976) to rank challenges based on mutual influence. Their results offer a

holistic perspective on understanding global challenges. They discuss the potential of a suitable Global Strategy to inspire new approaches for harmonizing subsystems with the broader interconnected web and its environment. The objective is to establish a trajectory towards sustainability.

A systems approach to understanding the Royal Navy's organisational health.

Miss Eleanor Doyle[1]
[1]Ministry of Defence

Parallel 8 - Systems Thinking 3, Room 5.1, September 14, 2023, 09:00 - 10:30

Biography:
Eleanor is a civil servant working in the Royal Navy's Performance Group.

Royal Navy's Performance Group has developed a systems approach to understanding the health of our organisation. The Royal Navy has a wide range of roles with activity around the world, every day.

This approach uses a hierarchical set of key success factors to link together metrics – both quantitative and qualitative, risk data and activity data. Our approach is designed to support collective discussion amongst our most senior leaders to their support complex decision making.

This session will describe the design and development of this systems approach, reflect on early implementation experiences, and highlight areas for development into the future. It will also evaluate the benefits of taking a systems thinking approach that matches up to the complexity of the Royal Navy.

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Using Variety Dynamics to take control of coercive systems

Dr. Terence Love[1], Dr Trudi Cooper[2]
[1]Love Services Pty Ltd, [2]Edith Cowan University

Parallel 8 - Systems Thinking 2, Room 4.5, September 14, 2023, 09:00 - 10:30

Biography:
Terence has been involved in systems design, systems thinking and systems research since studying control systems and design optimisation via AI at Lancaster University. Recent systems research has been in the development of Variety Dynamics as a new systems field and new area of mathematics for managing and taking ownership and control of complex and hyper-complex systems; and identifying biological bounds relating to systems. Terence is also a professor of industrial design at a Middle Eastern university, with over 120 publications and provided research and training services to Federal, State and Local Government agencies, businesses and NGOs in Australia and internationally. In the last three years he has provided review services for over $3billion of built infrastructure.

This paper outlines the practical applicaiton of four of the 37 axioms of Variety Dynamics to take ownership and control of complex coercive systems. It begins by providing a brief overview of the core concepts and theory foundations of Variety Dynamics as it applies to complex and hyper-complex systems and explains why Variety Dynamics is a completely different form of system approach to the conventional mechanistic Systems Thinking approaches such as Soft Systems Methodology, System Dynamics, Critical System Heuristics, Total Systems Interventions, 'Wicked Problems' and Non-linear Control Theory. The paper outlines the key reasons why and how Variety Dynamics is more effective than the above conventional systems thinking methods at guiding management decisions intended to take control and ownership of complex systems situations particularly in multi-actor situations, e.g. warfare, politics, industrial negotiations, large organizations, business startups, counter terrorism, health disaster management and industry competition. The above are demonstrated via four practical examples.

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Systems Thinking and Practicing as a Cultural Anthropologist in Evaluation and Public Health

Dr. Eve Pinsker[1]
[1]School Of Public Health, University Of Illinois At Chicago

Parallel 8 - Systems Thinking 3, Room 5.1, September 14, 2023, 09:00 - 10:30

Biography:
Eve C. Pinsker, PhD is clinical assistant professor in the Community Health Sciences Divisions of the University of Illinois at Chicago (UIC) School of Public Health, and serves on the core faculty for the DrPH (Doctorate of Public Health) in Leadership Program at UIC SPH. She has over 30 years of experience as an evaluator, and is a founding member of the Systems in Evaluation TIG at the American Evaluation Association and a Trustee of the American Society for Cybernetics. Her PhD is in Cultural Anthropology (University of Chicago 1997). Her 3 years of dissertation field research in the Federated States of Micronesia focused on the systemic connections among multiple levels of political community in a multi-island, multi-cultural emerging nation, and she later adapted and applied her theoretical framework and methodology to the evaluation of collaborative community initiatives and health leadership development programs, and to her mentoring of UIC DrPH students.

Within the discipline of anthropology, "practicing anthropology" is used to refer to the application of anthropology to practical problems from a professional base outside of academic anthropology departments. "Evaluation Anthropology" (O'Dell Butler 2015, Copeland-Carson et al 2005) refers to the application of cultural anthropology as a professional evaluator of programs and initiatives. The author serves as the chair of the Evaluation Anthropology interest group of the US based National Association for the Practice of Anthropology (NAPA). She has worked as a professional evaluator for several decades, most recently as a faculty member of a professional doctoral program (DrPH) in a school of public health contracted to work on evaluation and community engagement in environmental and community health projects. In her experience, much of the utility of anthropological approaches to evaluation of public health related programs and initiatives rests in the relationship of systems thinking to social theory and ethnographic method, although that is not often explicitly recognized. Specifically, the author's roots in the work of Gregory Bateson and Margaret Mead, progenitors of second-order cybernetics via their leadership in the post World War II Macy conferences, has enabled her to recognize and analyze the complex relationships between representations (what people say and write) and activities/practices (what people do) and how that affects the outcomes at multiple socio-ecological levels (organizations, collaboratives, communities) of public health initiatives intended to promote systemic change. This is illustrated by exploring how "community engagement" and "community power building" is discussed, explored, and evaluated by

public health academicians and professionals in the context of several recent initiatives, and contrasting the insights that come from a deeper understanding of the systemic, mutually causal relationships among actors, the taken for granted assumptions that shape their perceptions (cultural models), and the constraints stemming from the limits of material resources. These challenges take on greater resonance in the context of initiatives that aim to challenge the persistent inequities that the COVID-19 pandemic highlighted.

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Achieving Impact in Large Healthcare Organizations: Challenges and Opportunities

Dr Mark Tuson[1], Daniel Gartner[1]
[1]Cardiff University

Parallel 8 - Systems Thinking 1, Room 3.5, September 14, 2023, 09:00 - 10:30

Biography:
I am an early career researcher, my main research interest is in stochastic OR; hybrid simulation and simulation optimisation, heuristics, mathematical modelling and forecasting, usually in the context of healthcare systems. In 2021 I was a recipient of the Lyn Thomas Impact Medal (The OR Society).

The challenges of implementing OR initiatives in healthcare settings and subsequently measuring their impact are well documented. This presentation draws on the experience of two researchers-in-residence who besides their academic role have embedded roles within large healthcare organizations in the U.K. Using examples of mathematical modelling, this talk provides a reflection of challenges but also opportunities involved in implementation and measuring impact.

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Systems thinking and mapping in mission-oriented policy: ambiguity, diversity, plurality

Dr Ine Steenmans[1]
[1]University College London

Parallel 8 - Systems Thinking 1, Room 3.5, September 14, 2023, 09:00 - 10:30

Biography:

Dr Ine Steenmans is an Associate Professor in Futures, Analysis and Policy at the University College London (UCL). Ine's research focuses on future policy competencies and capabilities. What analytical competencies do policy professionals need, and how do they develop them? How do groups develop collective analytical capabilities? And how can the development of competencies and capabilities be better aligned?

She has an especial interest in the competencies for integrating knowledge across disciplines, sectors, and time horizons. This includes futures and foresight methods, systems methodologies, and evaluation. All her work takes a needs-led, transformation-oriented approach, which involves working in partnership with policy professionals. Recent projects included capability development work on the uses of systems mapping, evaluation skills, scenarios, and strategy tools – in collaboration with BEIS, Lloyds Insurance, UNDP, Policy Lab, the UAE Office of Advanced Sciences and the UAE Space Agency. Before joining UCL in 2017, Ine worked as a foresight researcher in the UK Government Office for Science.

She obtained her MEng in Civil and Environmental Engineering from Cambridge University, followed by an MSc in International Planning at the Bartlett School at UCL, and an EPSRC-funded Engineering Doctorate (EngD) at the UCL Centre for Urban Sustainability and Resilience.

A significant enthusiasm for more widespread systems thinking in UK public policy has led to the promotion of 'systems mapping' methods for designing policy. In the last 5 years alone, multiple memos from senior civil servants have encouraged colleagues to use 'systems thinking' and 'systems mapping' methods. A recently released "systems toolkit" (2022) encourages policy analysts to 'map systems' for achieving more holistic understanding of challenges faced. One area within which systems mapping been enthusiastically adopted is that of mission-oriented policy design, in which cross-sectoral sustainable development challenges seek to align the interconnected activities of diverse stakeholder groups (see Bennett and Steenmans 2019; Mazzucato and Dibb 2019; OPSI 2020).

This paper responds to observed confusion amongst those working on mission-oriented policy design around what a systems mapping methodology *is*, and what practical choices

mean ‘better’, or ‘worse’ uses of that systems thinking method. Feedback from participants in systems map development suggests that the ambiguity around what systems mapping is can lead to confusion, insecurity, frustration and even exclusion from process. It are often the systems thinking practitioners and facilitators who attempt to acknowledge and demystify the diversity, plurality and ambiguity encountered in using methods to apply systems thinking.

This paper aims to support to such demystification efforts by contributing a comparison of different ontological, epistemological, and axiological assumptions made in 5 UK civil service mission-oriented projects that all used at first sight seemingly similar systems mapping methods (2019-2023). Across these 5 case studies I explore what ontological and epistemological beliefs were held about what exists that can be mapped for a mission policy system. I trace how those beliefs informed choices in the use of systems mapping methods, and how those provide contrasting illustration of the affordances of systems mapping methods. Finally I reflect on the ways concepts of validity were treated across the five cases and what that means for practitioners.

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Towards systems thinking by exploring literary fiction and causal mapping

Dr Leila Abuabara[1], Professor Alberto Paucar-Caceres, Katarzyna Werner-Masters
[1]UNIFESP - Universidade Federal de São Paulo

Parallel 8 - Systems Thinking 2, Room 4.5, September 14, 2023, 09:00 - 10:30

Biography:
I am a PhD candidate in the Pos-graduation Programme in Operational Research at UNIFESP (Universidade Federal de São Paulo) and ITA (Instituto Tecnológico de Aeronáutica) in São Paulo/Brazil. I hold a master's degree in the same programme.

My research interests mostly lie in the areas of Soft OR, Problem Structuring Methods, Systems Thinking, Decision Analysis and multimethodologies, in particular in the combination of causal mapping and Strategic Options Development and Analysis (SODA) in practical applications focusing on real and social situations. Some published research includes the areas of educational policies, food planning during pandemic, organizational strategies, circular economy, and systems thinking development for OR practitioners.

Great works of literary fiction mirror life and its complexity. In this research we attempt to explore the linkages between Literature, especially fiction literary through narrative pieces, and Operational Research/Management Science (OR/MS), two seemly divergent fields of knowledge, to expand our understanding of complex human affairs aiming to enhance our systemic thinking skills. Using the experience of reading a fiction book in a group reading programme, we applied Causal Mapping (CM) to Reading Labs, where participants read and share their views of a same fiction work to appreciate the complexity of multiple and differing reading perspectives. The approach we adopt hinges on the relationship between literature and OR, two disciplines which belong to different fields of knowledge (humanities and science, respectively), but when examined in more detail, connect in meaningful ways. We explore this connection to identify potential gains of increasing systemic thinking awareness in the reading groups' context. In this experience, the resulted map is analyzed in its structure through constructs classification, dominance evaluation based on the degree centrality and goals positioned in the head constructs. The findings of this interdisciplinary study show that use of CM (i) enhances systemic thinking by producing a synthesis and shared views on what was meaningful and useful; and (ii) translates the subjectivity produced by the shared reading experience into new actions strengthened by systemic thinking awareness. The participation was a way of opening minds to new possibilities, including to better professional and personal attitudes and practices. These results should be of interest to Soft/OR practitioners using CM and systems practitioners working on encouraging the use of systems thinking in systemic interventions.

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The virtues of systems thinking

Mr Gary Smith[1]
[1]Airbus

Parallel 9 - Systems Thinking 4, Room 4.1, September 14, 2023, 11:00 - 12:30

Biography:

Gary Smith is a Senior Expert Systems Engineer at Airbus Defence and Space. He is their overall architect for engineering processes and provides technical leadership in the digital transformation of the division. He is an INCOSE certified Expert Systems Engineering Professional and a senior editor of the Systems Engineering Body Of Knowledge.

Systems practice has been a continuous theme through Gary's life experience. He began his career as a lab technician in industrial chemistry at the age of 16, he taught himself how to write software applications in the early 80s, and then after his chemistry degree moved on to relational database systems, software development and project management. As a Project Manager, he was responsible for the delivery of telecommunications infrastructures across Europe before taking on the corporate leadership of the PM discipline. Later, Gary was recruited by Airbus to develop the discipline of technical management and worked to bridge the SE and PM disciplines. During this time with Airbus, he has had several roles as Chief Engineer and Architect of System of Systems Solutions.

Gary's passion extends beyond his professional work and into areas of personal interest to understand the nature of things, to appreciate complexity and to address the big 'why' questions. Since the early 2000s Gary has been applying systems thinking to topics such as cancer, inflammation, sepsis, and pre-eclampsia. Building upon this interest he has co-authored two best papers at INCOSE:

- *2016, Architectural parallels between biological and engineered solutions in defence and security*

- *2018, A successful use of systems approaches in cross-disciplinary healthcare improvement*

Since 2019 he has been the VP for Systems Practice at the ISSS and their relationship manager with INCOSE.

Systems thinking has emerged as a crucial approach in comprehending and addressing the ever-increasing complexities and challenges of our modern world. With a multitude of frameworks and schools of thought, it is essential to explore how best to apply systems thinking within specific contexts. This presentation aims to shed light on the concrete outcomes and practical benefits of embracing systems thinking, moving beyond mere abstract notions.

By adopting systems thinking, we unlock a range of virtues that enable us to grasp the intricacies of interconnected systems. We gain a holistic perspective, understanding how elements within a system interact and influence each other. This newfound comprehension allows us to identify and leverage leverage points—areas where small interventions can generate significant and sustainable changes. Systems thinking empowers us to view problems through multiple lenses, fostering creative problem-solving and innovative approaches.

Moreover, applying systems thinking yields tangible outcomes that surpass vague rhetoric. By embracing this approach, organizations can enhance decision-making processes, mitigate risks, and uncover unforeseen opportunities. Systems thinking enables proactive anticipation and management of unintended consequences, minimizing the likelihood of unintended negative impacts. It equips leaders with tools to develop robust strategies that account for the interdependencies and feedback loops inherent in complex systems.

This presentation will articulate the virtues of systems thinking while highlighting the potential pathologies that can be avoided or mitigated by its application. By embracing systems thinking, we empower ourselves to navigate complexity, identify impactful interventions, and unlock concrete outcomes. Furthermore, by adopting contextually suitable heuristics, we optimize our ability to tackle challenges, drive innovation, and achieve desirable results in an increasingly interconnected world. Systems thinking is not merely a buzzword; it is a powerful framework that equips us with the tools and mindset necessary to thrive in a complex and uncertain future.

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A Systems Thinking Approach to Policy analysis and Implementation within the East Riding Drugs Partnership

Miss Chloe Singleton[1], Ms Melanie McKee[1], Mx El Wilkinson-Cunningham[1]
[1]East Riding Of Yorkshire Council Public Health

Parallel 9 - Systems Thinking 1, Room 5.1, September 14, 2023, 11:00 - 12:30

Biography:
The authors have a specialism in addictions and inclusion health, systems thinking, and community development interventions and evaluations. Together, they are currently working to implement systems thinking practices across East Riding of Yorkshire Council's Public Health team and beyond. The present work on drugs policy analysis and strategy development represents their first application of system thinking to strategic change.

The East Riding Drugs Partnership (ERDP) is piloting an application of systems thinking methods to a multidisciplinary local partnership and strategy, representing a whole-systems approach to addressing the UK Government's From Harm To Hope 10-year Drugs Strategy outcomes through evoking sustained, positive systemic change. A dynamic approach to this strategy is being taken to instil a flexibility in response to real-time changes in need, enabling positive reaction to effects from system actions and the constantly competing influences from across the wider political, social, and economic contexts. The present methodology has therefore been implemented with the intention of upholding the participatory and co-productive nature of this partnership, amalgamating the perspectives of policy actors situated from across the system to collectively frame our strategic outcomes and desired direction of change in terms of our local priorities. To this end, policy analysis, stakeholder and service mapping, rich picture analysis, systems thinking workshops, and qualitative stakeholder, family, and service-user consultation respectively, have been undertaken to establish a shared understanding of our system, its boundaries, and problematisations. Thematic analysis of each aligned with expectations that a culture of siloed working between teams and organisations is conducive to a general lack of awareness and comprehension of the system as a whole and highlighted the necessity of remediating this. Emerging priorities were identified as being the importance of robust strategic partnerships taking a unified, whole-systems approach to achieving each objective, instilling a proactive, preventative, and protective emphasis to the partnership. Using these insights, attention now turns toward co-designing and implementing change across our partnership and services. Converse to traditional strategic macro-objectives, the development of a novel theory of change will next be undertaken to encourage the use of innovative, micro-interventions to continuously shape the direction of our strategy and evoke the emergence of wider systemic changes to population health and wellbeing.

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Pressues on teachers - a systems thinking analysis

Dennis Sherwood[1]
[1]The Silver Bullet Machine Manufacturing Company Limited

Parallel 9 - Systems Thinking 1, Room 5.1, September 14, 2023, 11:00 - 12:30

Biography:

Dennis Sherwood runs now runs his own consulting business, Silver Bullet, having been a consulting partner in Deloitte, Haskins + Sells (a predecessor of PwC) and an Executive Director at Goldman Sachs.

Dennis is the author of many articles and blogs, the co-author of three books, and sole author of twelve others, including 'Seeing the Forest for the Tress - A manager's guide to applying systems thinking' (Nicholas Brealey, 2002), and 'Strategic Thinking Illustrated - Strategy made visual using systems thinking' (Published by Routledge, 2022), which was short-listed in the 'Specialist Book Category' of the 2023 UK Business Book Awards.

Over the spring of 2023, the press carried many stories about the stress suffered by teachers as a result of Ofsted inspections.

This session will present a systems thinking analysis of the effect of performance measures on teacher behaviour, featuring a causal loop diagram identifying the drivers of those behaviours, and the behaviours themselves, as well as suggestions as to policies that are likely to result in the 'right' behaviours rather than the 'wrong' ones.

This case study therefore highlights the benefits of using systems thinking to tame the complexity of real systems, using an example of considerable topical relevance.

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Scaling up Structured Democratic Dialogue using hybrid virtual asynchronous processes

Senior Scientist Yiannis Laouris[1], Mr Kevin Dye, DR Gary Metcalf
[1]Future Worlds Center

Parallel 9 - Systems Thinking 4, Room 4.1, September 14, 2023, 11:00 - 12:30

Biography:
Leads internationally the theory and application of the science of structured dialogic design and conducts research towards developing systems to enable scaling up participatory dialogic processes to engage asynchronously thousands of people in meaningful authentic dialogues, thus accelerating institutional and societal change. Promotes the application of broadband technologies and structured democratic dialogue as tools to bridge the digital-, economic-, educational- and inter-personal divides in our planet. Social-, business-, and science entrepreneur; medical doctor, neuroscientist, educator, systems engineer, and IT expert. Lead scientist and Chair of Future Worlds Center. Founding member of several CSOs and high-tech companies, member of Board of Institute for 21st Century Agoras; national representative in several COST Actions, Insafe, Inhope, EU Kids online, ECSO, Cybercrime Centre of Excellence, ECTEG – Europol, and member of Boards and/or partner in several high-tech companies. One of the 12 authors of the ONLIFE Manifesto, and key author of Reinventing Democracy in the Digital Era Manifesto. Holds MD (distinction), PhD Neurophysiology (summa cum laude), MSc Eng (GPA 4.0), PhD Systems Engineering (pending). 80+ papers/book chapters; 160+ conference papers.

Structured Democratic Dialogue (SDD) has been widely and successfully employed to facilitate local and regional societal reforms. However, the current limitation of SDD lies in the number of stakeholders that can participate synchronously. To address this issue, the conventional approach has been to organize multiple events either simultaneously or sequentially or to combine SDD with other methodologies. However, given the escalating rate of change and the rapidly growing complexity of challenges, there is an urgent need for effective large-scale reforms. In this presentation, the author will introduce innovative approaches that can significantly shorten the SDD process and enable the participation of ten times more stakeholders. Moreover, recommendations will be provided to enhance the quality of online and asynchronous sessions, along with qualitative and quantitative indicators that can be utilized to compare and evaluate both face-to-face (f2f) and virtual implementations.

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Systems Thinking for Systemic Governance: Enhancing Collaborative Working in a Sport England Pilot Project

Mx El Wilkinson-Cunningham[1], Mr Gerald Midgley, Dr Rachel Lilley, Mr Tom Crisp, Sharon Tabberer, Mr Paul Davies, Mr Joseph Brooks, Emma Kelly, Gill Davison, David Gent
[1]East Riding Of Yorkshire Council

Parallel 9 - Systems Thinking 1, Room 5.1, September 14, 2023, 11:00 - 12:30

Biography:
El Wilkinson-Cunningham is the Evaluation Co-ordinator for Active Withernsea. El holds a 2:1 undergraduate degree in Forensic Pyschology (Hons) from Leeds Trinity University and a Masters degree in Investigative Psychology from The University of Huddersfield. They have had a career in behaviour change, working in substance misuse services and inpatient forensic units before moving on to work in research and evaluation. They has worked on a number of research studies, including investigating the use of Schema Therapy in treating Borderline Personality Disoder; exploring the use of Qbtesting within a youth offenders institute to detect ADHD; Evaluation of SECURE STAIRS and Novax COVID trials.

Active Withernsea (AW) is one of 12 pilots funded by Sport England to test innovative approaches that focus on system changes to increase physical activity levels that are replicable and sustainable in a disadvantaged local community. The early governance structure of AW was complex, made up of multiple partners, a board of directors and an operational board, all with different oversight responsibilities. As the systems-change remit of AW took shape through several strategy workshops using our Systemic Intervention approach, those involved in governance started to express dissatisfaction with both the complexity of that governance and a lack of alignment with the systems change work of AW: the AW employees were proactively engaging with the community and partner organisations to remove barriers to physical activity, but governance was focused on reactively looking at AW's performance instead of contributing to the systems change. Our Systemic Intervention therefore turned attention to rethinking the governance: Critical Systems Heuristics questions (about the motivation for, control of, expertise required for, and legitimacy of governance) were embedded in an Idealized Design process, giving rise to the Physical Activity and Community Engagement (PACE) Network. This is an innovative new governance approach which moves away from mere oversight of what AW is doing to a collaborative network of partners and residents working together to be ambassadors for physical activity within the town. Quarterly workshops which use intentionally generative, open and co-creative approaches are being facilitated with the network, exploring complex challenges affecting physical activity that require significant collaboration to address them. Thus, governance now proactively informs the work of AW, as opposed to just reactively holding it to account. This fosters a culture that genuinely favours the collaborative

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engagement with challenges, as opposed to a more defensive impression-management culture. This openness to innovations across the AW pilot allows for more transparency and empowerment of its residents and partners, laying the path for a sustainable network beyond the project's end in 2025.

Boundary Critique for Utilising Social Intervention Knowledge: A Sinosphere Perspective

Dr. Charles Leung[1]
[1]Beijing Normal University-Hong Kong Baptist University United International College (BNU-HKBU UIC)

Parallel 9 - Systems Thinking 2, Room 4.5, September 14, 2023, 11:00 - 12:30

Biography:
Dr Charles LEUNG is Assistant Professor of the Faculty of Humanities & Social Sciences at BNU-HKBU UIC. Before serving as a full-time academics, he was working as front-line social worker, as well as in various supervisory and managerial positions of nonprofit organizations across the regions of Guangdong-Hongkong-Macao Greater Bay Area (GBA). In addition to the social work background, he is also holding the qualifications of mediation (Hong Kong & Kyoto) and project management (IPMP; PMD Pro). Dr Leung has been applying the ideas of systems thinking and operational research in his academic and professional initiatives since 2010's. He presented in OR63 regarding a use of systems thinking for fostering the utilization of social development project in facing of an imbalance of stakeholders' power in Chinese context. The presentation this time is to depict the next stage of his research agenda about the uses of Ubuntu, an African philosophy, in the socio-cultural contexts across the South-East Asian regions, including but not limited to Vietnam, Laos, and South China for developing social work education.

This presentation aims to elucidate the author's efforts to develop a theory of knowledge utilisation based upon systems thinking ideas, which the author has been synthesising through research and teaching work since the 2010s. The author's work has focused on promoting the use of evidence-based interventions and internationally standardised methods in East Asian countries. Recent research on Ubuntu, an African philosophy promoted by international social work organisations, has led the author to propose a heuristic framework for stakeholders' deliberative planning on its useful implementation in local settings.

The author seeks to illustrate the axiomatic and methodological considerations underpinning the framework by clarifying several key concepts. Stakeholder analysis is crucial within the framework to understand the complexity of knowledge utilisation, which depends upon their respective concerns in a particular real-world setting. The author adopts critical realism as the philosophical orientation to rationalise how stakeholders interpret the utilisation of social work knowledge, such as Ubuntu. Boundary critique is a core idea in critical systems thinking that formulates various mediation strategies to facilitate the process whilst acknowledging the researcher's vested interest is inevitable. The author

employs the concept of 'Tai Chi' to translate ideas of systems thinking, particularly those related to issues of power imbalance, into practice. Consequently, the author emphasises that participatory practice research is not only a technical but also an ethical and political exercise that demands conceptual support from reflexivity and resources of virtue ethics philosophy.

The proposed framework is expected to contribute to the transnational circulation of Ubuntu and other social intervention knowledge and its utilisation, particularly in three areas. Firstly, it can articulate the complex dynamics of stakeholders in the process. Secondly, it can illustrate how stakeholders can acquire a power balance. Thirdly, it would be more useful in settings where stakeholders are significantly influenced by a Sinosphere tradition. If academics and practitioners of operational research can understand and apply the framework, they could attain more desirable outcomes and impacts.

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Mapping Strategic Visions for Systemic Interventions

Dr Jenneth Parker[1]
[1]Schumacher Institute For Sustainable Systems

Parallel 9 - Systems Thinking 2, Room 4.5, September 14, 2023, 11:00 - 12:30

Biography:

Jenneth Parker has worked in sustainability since the 1990s, initially in Education for Sustainability (EfS) with a special emphasis on knowledge and processes for sustainability strategies. She has an interdisciplinary PhD from the University of Sussex and is a qualified adult educator. Jenneth maintained her interest and work in methodology for interdisciplinary work on sustainability and this led to research work in the University of Bristol. She used mixed method social science approaches in a study on Management of Change in the Public Services, and later worked with the multi-million NERC funded QUEST project to add biotic feedbacks (including marine feedbacks) into climate models. Her role was to organise the interdisciplinary synthesis phase of the project and she has published on this. Jenneth then became the lead researcher with the Schumacher Institute -led EU funded CONVERGE project, with a brief to bring interdisciplinary approaches and synthesis to systems dynamics analysis carried out in the project.

Jenneth also carried out consultancy for organisations such as UNESCO on learning and education for sustainability, including understanding of system transitions. Further research work focused on societal transitions to sustainability included working with the Marie Curie Adapt Econ II project, with 12 PhDs using systems dynamics analysis to look at renewable and non-renewable resources with respect to the wider landscape of climate, biodiversity and equity challenges. Recent work includes leading a review of transition literature to develop a framework for Water Transition in England, commissioned by the Environment Agency. Currently she is working on a Schumacher Institute project 'Stuck in Transition' with Professor Ragnarsdottir and Dr Ingrid Stjernquist from Stockholm University. This asks the wide question 'how do we get 'Stuck in Transition?' looking at identifying systems embedding, path dependency and resilience of embedded systems against change, to help identify more effective strategies.

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This presentation explores an example of methodological innovation in applied systems thinking which provides a bridge between two complementary areas of systems thinking - that of Gerald Midgley's account of Systemic Intervention and developments in the application of System Dynamics in representation and modelling. The context is an extensive piece of developmental research commissioned from the Schumacher Institute by the English Environment Agency which aimed to present a framework that could be utilised for moving to a Water Transition approach in England.
The paper shows how the various challenges of the task prompted an application of CLD mapping and protocols to illustrate the transdisciplinary proposals for Water Transition as a (complex) Systemic Intervention involving several key interacting components and placed in wider changing scenario contexts. This is significant as helping to provide:

a transdisciplinary perspective by linking it to other tools which prompt insights across a 'deep interdisciplinary' range
a 'Transition Object' which can be the focus of mutual development and co-creation of strategic visions and solutions across a wide range of stakeholders
an extension of the tools available for future vision of new systems - often under-served by modelling which mostly concentrates on presenting the system of concern as it currently operates and then proposing adjustments (piecemeal or 'tweaking parameters')

The conclusion is that this and other yet-to-be-developed methodological innovations are needed to help us move towards the transformational approaches that are required to respond to our civilisational crises of biodiversity collapse, climate chaos, and escalating inequality.

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A Whole-System Benchmarking Model for Wastewater Service Considering Interactions Between Sub-systems and the Remote-Environment using Simultaneous Multi-Variate Structural Equations Modelling: A case study in Japan.

Mrs Yasmin Jaaron (abu Al Hla)[1], Professor David Saal[2]
[1]Loughborough University, [2]Loughborough University

Parallel 9 - Systems Thinking 4, Room 4.1, September 14, 2023, 11:00 - 12:30

Biography:
Yasmin Jaaron is currently a final year PhD student at the School of Business and Economics (SBE) at Loughborough University. In 2013, she received her bachelor's degree in Industrial Engineering from the Industrial Engineering Program of An-Najah National University in Palestine as a top student of her batch. She also received her master's degree in Engineering Management from the same university in 2019. Yasmin has worked on her thesis in operations research, optimizing a green vehicle routing problem integrating occasional drivers' differences. Currently her PhD research is now being conducted in Economics at the SBE school of Loughborough university, working with her supervisors on a multidisciplinary project which requires both economics and engineering knowledge and backgrounds. Mainly, employing hybrid methodologies from engineering and economics for developing exploratory and optimization models, involving Structural Equation Modelling (SEM), Cost-Benefit Analysis (CBA) and mathematical optimisation modelling based on Graph theory.

The wastewater sector faces environmental and operational challenges that impact its ability to provide sustainable services. This research focuses on the inherent complexity design of Wastewater Systems (WWSs), given inter-dependency between sub-systems, that causes costs interactions and would result in biased cost benchmarking. Furthermore, sub-system characteristics are influenced by the remote environment, which impacts service demand patterns and the configuration of WWSs. It is therefore necessary to account for topographic and demographic characteristics while also accounting for direct and indirect cost interactions between subsystems. This paper therefore provides an integrated whole system cost model using the simultaneous Partial Least Squares Structural Equation Modelling (PLS-SEM) approach. This method has allowed development of a robust cost benchmarking model for whole-system operation and maintenance cost (WSOPEX) using a case study in Japan, where systems are particularly complex. Our analysis of 138 fully integrated and 223 collection-only WWSs, with Multi-Group Analysis (MGA), statistically demonstrates the need for different group models. All proposed cost drivers were also found to significantly influence WSOPEX, further highlighting the importance of external characteristics. Thus, while the direct effects of surrounding terrains on WSOPEX were

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found insignificant in both groups, both their indirect effects are strong and significant at 1 percent. While we can reject the existence of a statistically significant difference between the direct path coefficients for the remote environment factors between the two groups, statistically significant differences exist in the cost drivers related to the WWS characteristics. These findings suggest that wider factors should be explored to further understand what other external factors impact WSOPEX. Also, they demonstrate that pooled estimation would result in biased findings. Finally, unit cost estimates derived from our models are compared to the equivalent of the average unit cost benchmark employed in Japan, based only on size and density. While we demonstrate that their approach can capture some of the variation in unit costs, much of it is not explained. Thus, the PLS-SEM unit cost benchmarks improve substantially on current benchmarking because they provide individual WSS specific estimates that control for substantial within the group variation in scale, density, and other operating characteristics.

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Exploring a complex government customer service system using Causal Loop Mapping: A facilitated workshop based on challenges faced by HM Revenue and Customs.

Dr Ben Follows[1], Mrs Andrea White[1], Mr Ben Spurway[2]
[1]HM Revenue & Customs, [2]Leadership College for Government

Parallel 9 - Systems Thinking 3, Room 4.8, September 14, 2023, 11:00 - 12:30

Biography:
Ben is a senior OR manager with 20 years plus experience working within the Government Operational Research Service (GORS) mainly for HM Revenue and Customs. Ben's current role is to lead a set of cross cutting strategy and innovation analysis teams, to build capability and inform HMRC transformation and strategy. Ben has a wide ranging interest in the practical applications of OR in Government, ranging from systems thinking, soft OR, evaluation, modelling, insight and data analytics.

Link to GORS: http://www.operational-research.gov.uk/recruitment

The interactions between colleague experience, customer service, customer experience, tax complexity and compliance are numerous and complex and mean that simple solutions are rarely appropriate. In this workshop we will introduce the concepts of systems thinking and the application of Causal Loop Mapping. Drawing on the systems thinking guide for civil servants we will explore a generic government customer service system archetype and we invite participants to collaborate, develop their own system thinking skills, identify feedback loops and systems behaviours. We will reflect on the findings from the session and wider learning from HMRC.

Link to the systems thinking guide for civil servants:
https://www.gov.uk/government/publications/systems-thinking-for-civil-servants

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Where to Next for Systems Thinking?

Mr Gerald Midgley[1], Dr Rachel Lilley[1]
[1]University of Hull

Parallel 10 - Systems Thinking, Room 5.1, September 14, 2023, 14:30 - 16:00

Biography:

Gerald Midgley is Professor of Systems Thinking in the Centre for Systems Studies, Faculty of Business, Law and Politics, University of Hull, UK. He also holds Visiting or Adjunct Professorships at Linnaeus University, Sweden; the University of Queensland, Australia; and Mälardalen University, Sweden. He has held research leadership roles in both academia and government, having spent twelve years as Director of the Centre for Systems Studies at Hull, and seven years as a Senior Science Leader in the Institute for Environmental Science and Research (ESR), New Zealand. Gerald has written over 300 papers for academics and practitioners on systems thinking and community operational research, and has been involved in a wide variety of public sector, community development, health service, technology foresight and resource management projects. He was the 2013/14 President of the International Society for the Systems Sciences, and has written or edited twelve books. These include: Systemic Intervention: Philosophy, Methodology, and Practice (Kluwer, 2000); Systems Thinking, Volumes I-IV (Sage, 2003); Community Operational Research: OR and Systems Thinking for Community Development (Kluwer, 2004); Forensic DNA Evidence on Trial: Science and Uncertainty in the Courtroom (Emergent, 2011); and the Routledge Handbook of Systems Thinking (Routledge, 2023, in press).

This is a 90-minute, Open Space workshop to identify the most pressing concerns about systems methodology and practice that need to be the focus for the next couple of years of research. Participants will volunteer research topics, then form into small groups according to where their passion for contributing lies. Each small group will create an outline research agenda, then present to the rest of the participants. Every group that decides it wants to act on the discussion after the workshop will volunteer one person as a contact point. Anyone in the room can then ask to be part of that action going forward, and can give their email addresses to the contact person.

Transportation

Enhancing Delivery Scheduling Efficiency through Flexible Day and Time Windows: A Parallelised ALNS Approach for Large-scale Vehicle Routing

Mr Kiko Rullan[1], Mr Matt Simmons, Mr Adil Rahman, Dr Jeremy Bradley
[1]Datasparq

Parallel 1 - Transportation, Room 4.10, September 12, 2023, 09:15 - 10:45

Biography:
Kiko studied Inverse Problems applied to medical imaging during his PhD at the Department of Computer Science at UCL. Since he graduated in 2020, he has been working at Datasparq in a variety of Machine Learning projects to deliver data products to a number of companies in different sectors, mostly in retail and transports. In the last two years, he has been implementing a metaheuristics solver for the Vehicle Routing Problem with a strong focus on scalability and strategic exploration.

This presentation showcases our solution for a large-scale vehicle routing problem involving over 2,000 delivery calls originating from a single depot. In collaboration with a multinational logistics company, the Datasparq team aimed to reduce serving costs within their delivery network. To achieve this, we implemented flexible delivery days and time windows, resulting in more than 10% savings compared to our baseline schedule.

The core of our solution is based on Adaptive Large Neighbourhood Search (ALNS), a metaheuristic algorithm that optimises weights for various insertion and removal heuristics. We enhanced ALNS by introducing a parallel framework to update the weights. Additionally, we incorporated subgraph heuristics to reduce exploration space and improve computational efficiency during each iteration.

Our solver operates on a distributed architecture with hundreds of CPUs available for a single experiment. This significant level of parallelisation enables the discovery of competitive solutions within a matter of hours, meeting the critical requirement of deploying the research results in a production environment. We delve into the challenges faced and design decisions made during the implementation of our solver.

To summarise, this presentation highlights: (a) an extension of ALNS to a parallel framework, (b) the architecture of our parallelized solver, and (c) computational results showcasing the effectiveness of flexing delivery day and time window constraints.

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Enhancing last mile logistics efficiency and sustainability through autonomous technologies

Dr Cheng Chen[2], Professor Emrah Demir[1]
[1]Cardiff Business School, Cardiff University, [2]School of Transportation and Civil engineering, Fujian Agriculture and Forestry University

Parallel 1 - Transportation, Room 4.10, September 12, 2023, 09:15 - 10:45

Biography:
Emrah Demir is a Professor of Operational Research in the Logistics and Operations Management Section of the Cardiff Business School. Emrah's current research interests are positioned within the areas of green logistics and operational research. He has mainly worked in the application of mathematical optimisation to real-life freight transportation problems. He has expertise in quantitative and analytical methods, such as exact and approximation methods. He has published more than 40 journal articles and five book chapters and has currently more than 4,500 citations to his publications on Google Scholar. Emrah has the following editorial roles: Area Editor of Journal of Heuristics; Associate Editor of IMA Journal of Management Mathematics; Associate Editor of Frontiers in Future Transportation - Freight Transport and Logistics; and Associate Editor of OR Spectrum Journal.

The increasing popularity of online shopping has transformed last mile logistics into a key service for individuals of all age groups. As urban areas witness a rapid surge in e-commerce activities, logistics service providers (LSPs) are looking for alternative and greener solutions to meet the escalating demand. With the advancements in automation and robotic technologies, LSPs have now the opportunity to integrate autonomous solutions, such as drones and delivery robots, into their daily operations. This research explores the potential of autonomous technologies in comparison to the traditional delivery van service, with a focus on improving the efficiency and effectiveness of last mile operations for LSPs. We propose a novel vehicle routing problem that takes into account the inclusion of heterogeneous and autonomous technologies as delivery assistants. To address this problem, we introduce a hybrid metaheuristic algorithm that combines genetic algorithm and large neighborhood search algorithm. Through extensive computational experiments, we evaluate and compare different configurations of delivery assistants, shedding light on their performance and implications for the logistics industry. Our findings provide valuable insights for LSPs that may consider these promising new delivery solutions. With this new last mile service option, LSPs can enhance their last mile logistics operations, optimize resource utilization, and contribute to greener urban environments.

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A column-and-row generation algorithm for allocating airport slots

Ms Paula Fermin Cueto[1], Dr Sergio García Quiles[1], Prof Miguel F Anjos[1]
[1]University of Edinburgh

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

Biography:
Paula Fermin is a third year PhD student in Optimization and Operational Research in the School of Mathematics, University of Edinburgh. She is interested in integer and combinatorial optimization and solving real-world problems, especially in the area of aviation. Her research is concerned with using mathematical optimization to solve the airport slot allocation problem to optimality. She is working with Airport Coordination Limited to create a slot allocation software that will improve the speed and solution quality of their current process. Before she started her PhD I worked in various analytical roles in Edinburgh Airport, Decision Lab UK and British Airways.

Air transport demand often exceeds capacity at congested airports. For this reason, airlines need to be granted permission to use airport infrastructure. They must submit a list of regular flights that they wish to operate over a five to seven-month period and a designated coordinator is responsible for allocating the available airport slots, which represent the permission to operate a flight at a specific date and time. From an optimisation perspective, this problem is a special class of Resource Constrained Project Scheduling Problem (RCPSP) where the objective is to minimise the difference between the allocated and requested flight times subject to airport capacity constraints and other operational restrictions.
Most studies on this topic focus on developing fast heuristics and complex models that capture the needs and particularities of various stakeholders. Real world instances of the slot allocation problem are thought to be too hard to be solved to optimality with exact methods.
In this work we show that it is possible to find optimal solutions for large instances quickly and with modest memory requirements. We develop a column-and-row generation algorithm that capitalises on two interesting properties of airport slot allocation problems:
1. We have a good intuition about the optimal solutions, as it is known that, in real-world instances, the great majority of flights can be allocated to their requested time.
2. Most flights are regular services and airport capacity limits are typically constant throughout the season. This introduces an element of periodicity in the problem that results in a great number of identical or dominated capacity constraints.
We show the effectiveness of this algorithm using real-world data provided by Airport Coordination Limited (ACL) from the most congested airports in the United Kingdom.

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LOGOS+: an integrated packing and routing model

Dr Congzheng Liu[1], Miss Jing Lyu[2], Mr Ke Fang[2]
[1]Decision Lab, [2]Lancaster University

Parallel 10 - Transportation, Room 4.10, September 14, 2023, 14:30 - 16:00

Biography:
Dr. Joshua Liu is an experienced consultant with expertise in optimisation and heuristics. He focuses on developing cutting-edge heuristics models for inventory management problems, scheduling problems and logistics problems.

He is active in the academic field, published multiple research papers on top-level journals. He is the member of the Operations Research Society, the member of the Centre for Marketing Analytics and Forecasting, and a visiting researcher at Lancaster University. He has recently developed an integrated logistics model for rail to last mile packing and routing problem. The commercial projects he has participant includes the supply chain improvement for GSK, the development of the risk map formulation algorithm for LFRS, the formulation and development for the Cora Systems project management problem, and the development of the optimal senser placement solver to support a machine learning project for Aeris (and its US government client).

In real-world logistics problems, the “packing” and “routing” decisions are usually required to be considered simultaneously, and the overall cost is more of interest to the decision maker than the individual costs. However, in early works in the field of OR, these two procedures are often treated independently. We argue that, since the packing is normally considered a priori the routing, it is difficult to take destination information into account during packing. As consequence, poor packing decisions might impact the routing in an unexpected way, possibly leading to sub-optimal solutions. To overcome it, we propose a rich and realistic formulation of an integrated packing and routing model. We show analytically that the solution of our integrated model is different from that of the traditional separated packing and routing model, achieving lower overall cost in most cases. Moreover, we propose a set of constructive heuristic algorithms as solution methods. Each algorithm is tested separately under extensive experiments. We claim that our proposed methods can solve the problem accurately and efficiently. Finally, we explore the possibility of selecting algorithms in an automated fashion using an artificial neural network.

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A Saving-based Heuristic for the Two-stage Supply Chain Network Design with Fixed Costs

Dr Srirangacharyulu Brundavanam[1], Dr Ram Kumar P N[2]
[1]IIM Visakhapatnam, [2]IIM Kozhikode

Parallel 10 - Transportation, Room 4.10, September 14, 2023, 14:30 - 16:00

Biography:

Srirangacharyulu holds a Ph.D. from Indian Institute of Technology (IIT) Madras. His dissertation focused on developing exact and heuristic algorithms for scheduling problems with non-regular performance measures. He obtained a bachelor's degree in Mechanical Engineering and a Master's degree in Industrial Engineering from Sri Venkateswara University, Tirupati.

A two-stage supply chain network design problem with fixed costs is considered in this paper. A single product has to be distributed from several plants to several customers through distribution centers. The plants have a limited capacity, and the customers have a specified demand. In addition to the variable cost which depends linearly on the quantity transported, in practice, a fixed cost is incurred when the shipment happens across a route irrespective of the quantity shipped. Examples of fixed costs include permit fee, rental costs, etc. The fixed costs make the problem practical, but more complex to solve. Jawahar and Balaji (2009) and Raj and Rajendran (2012) proposed Genetic Algorithms to solve the problem. Vinay et al. (2013) proposed an Ant Colony optimisation algorithm; Balaji and Jawahar proposed a Simulated Annealing based algorithm to solve the problem. A saving-based heuristic is proposed in this paper. The proposed heuristic starts with an initial solution and then the solution is improved iteratively using a saving mechanism. The heuristic method proposed in Srirangacharyulu and Srinivas (2017) is used to obtain the starting solution with the objective of minimising the total distribution cost. A saving value is computed for every unallocated route to improve the solution. A positive saving value indicates a scope for improvement. When all the saving value are negative the algorithm terminates. The proposed heuristic is tested with benchmark problem instances available in literature, and it is found that the results are encouraging.

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Introducing WORAN: The Women in OR and Analytics Network

Dr Frances O'brien

Poster Presentations, Lecture Theatre, September 13, 2023, 10:50 - 12:20

In 2018, the OR Society sponsored three MSc student projects exploring issues relevant to women in OR. One of the projects' recommendations was for the Society to set up a women's network. WORAN - The Women in OR and Analytics Network was established in 2019 with the aims:

- To advance knowledge, interest and education in Operational Research (OR), in as far as this concerns women.
- To support and empower women (and girls) considering a career in OR or working/studying in OR to enable them to overcome barriers to full participation in their analytic careers

WORAN currently focuses on three initiatives:

- Organising events: online, at conferences and the annual Land Lecture.
- Social media and PR to promote WORAN and its activities
- Mentoring women through different stages of their career

This poster will introduce WORAN, outline our previous, current and future activities, and show how you can get involved.

WORAN at OR65

Ms Ruth Kaufman[1]
[1]WORAN

WORAN at OR65, Room 3.9, September 13, 2023, 17:00 - 18:45

Biography:
Ruth Kaufman is Chair of the Events SubCommittee of the Women in OR and Analytics Network. She is a past President of the OR Society.

The Women in OR and Analytics Network was founded following three MSc student summer projects, identifying the disparity in numbers of women in senior positions in the OR community, and flagging up some of the issues. Our goal is to help overcome the barriers to women's full participation in their analytical careers.
Our drop-in session at OR65 will be open from 5pm on Wednesday 13th, for as long as people keep dropping in, up until 6.45 when we go off to get the coach to the gala dinner. If you would like to find out more about what WORAN does, share stories, ask questions, meet potential supporters/mentors, ask for advice, dole out advice to others, or just have a cup of tea or glass of wine in a convivial atmosphere, please join us.
This drop-in is not just for women. Issues around inclusion and diversity are everyone's issues, and making the most of the skills, energies and enthusiasms of everyone in the community is in all our interests.