

Plenary Speakers

Operations Research Challenges inside Air France-KLM

Jeroen Mulder

Plenary Speaker - Jeroen Mulder, KLM, The Eric Sunderland LT, September 10, 2024, 09:10 - 10:10

Biography:

Jeroen Mulder works for the Air France-KLM Group CIO Office as technology innovation project manager. He has a background in mathematics, a PhD in algebraic geometry, and more than 25 years of experience as operations research analyst and data scientist. He has extensive experience in setting up simulation, optimisation, and statistical models for various business divisions, like Operations Control Centre, Hub Control Centre, Engineering and Maintenance, and Revenue Management at Air France-KLM.

Jeroen worked and lived in Paris for five years as part of the French Operations Research team responsible for developing the forecasting and optimisation models in the joint Revenue Management system of Air France-KLM.

In his current role as technology innovation project manager his mission is to accelerate innovation inside Air France-KLM with new technologies judging the right balance between benefits and risks. Examples of such technologies include Generative AI and Quantum technologies.

This presentation will provide a detailed exploration of the major airline planning process at Air France-KLM, highlighting the strategic efforts undertaken to optimize each phase. The planning process spans long-term fleet management, network design, flight scheduling, fleet assignment, aircraft routing, tail assignment, and day-of-operations logistics, including the management of disruptions. Each of these phases is critical for ensuring the efficiency and reliability of the airline's operations, impacting customer satisfaction and the company's financial performance.

The decisions that need to be taken range from the type and number of aircraft to order years in advance, to which markets to open or close for the coming years, to which aircraft will operate the different flights based on the expected passenger demand for this year and handling unforeseen disruptions during day-of-operations, such as delayed flights, maintenance problems, and more. This complex web of decisions requires a deep understanding of market trends, customer behavior, and operational constraints.

The inherent complexity of these processes is driven by the interplay of diverse timelines, multiple stakeholders, and the stochastic nature of the airline industry. Key Operations Research challenges

currently facing Air France-KLM will be discussed, particularly those that could be improved but remain “as is” for the moment due to their computational and organizational constraints. These challenges include optimizing fleet utilization, improving network connectivity, and enhancing schedule robustness.

Some challenges lie at the intersection between successive process steps, where the joint optimization of these steps becomes intractable. They encompass optimizing fleet allocation, aligning network efficiency with market demands, combining revenue management with real-time information, and managing unforeseen events such as weather disruptions and technical malfunctions. Other challenges include the amount of data needed, how to measure the resulting small numbers, and how to validate the results from a business perspective. Addressing these challenges requires sophisticated modeling techniques and advanced analytical tools.

The presentation will also cover the methodologies employed to address how these challenges are dealt with on the day of operations, where they all come together in case of disrupted operations. The way Air France-KLM deals with the differing interests of the parties involved, how to assign value to them, and based on that, find the right balance between these interests will be presented, focusing on both the underlying mathematical optimization problem and the business transformation process needed to achieve this approach. This involves not only technical solutions but also effective communication and collaboration among various departments and stakeholders.

Some of the tools Air France-KLM is using to handle the complexity towards the day of operations will be presented, explaining how they support the work of our operational employees. These tools include advanced scheduling software, real-time monitoring systems, and decision-support systems that help operational staff make informed decisions quickly. The integration of these tools into daily operations ensures that the airline can respond swiftly and effectively to any disruptions, minimizing their impact on passengers and maintaining operational efficiency.

Can Operational Research improve well-being of healthcare?

Dr Sanja Petrovic

Plenary Speaker - Sanja Petrovic, The Eric Sunderland LT, September 11, 2024, 15:30 - 16:30

Biography:

Dr Sanja Petrovic is a Professor of Operational Research (OR) in Nottingham University Business School, UK. She has conducted and led multi-disciplinary research into development of models, heuristics and algorithms for a variety of real-world optimisation and scheduling problems, including radiotherapy planning, scheduling of patients, employee timetabling, production scheduling, vehicle routing problems and university timetabling.

Her research areas include optimisation methods and meta-heuristics, case-based reasoning, multicriteria decision making, data-mining, and fuzzy sets and fuzzy logic. Sanja has been the principal and co-investigator on projects mostly funded by Engineering and Physical Sciences Research Council (EPSRC) and Technology Strategy Board. Sanja was a Vice-president of the UK OR Society in two terms (2013-2018), Chair of the Committee of Professors of OR in the UK (COPIOR) 2018 - 2021, and a Co-ordinator of the EURO (European Association of OR Societies) Working group on Automated Timetabling since 2006.

Sanja is President-Elect of the Operational Research Society, with a forthcoming role of President in the period 2025-2026. She was a guest co-editor for special issues of the European Journal of Operational Research (EJOR), Journal of Scheduling and Annals of Operations Research. She is a Member of the International Advisory Board of the IMA Journal of Management Mathematics, Associate Editor of the Journal of Scheduling and a member of the Editorial Board of the Yugoslav Journal of Operations Research (YUJOR). She was Chair of the UK OR conference - OR53, held in Nottingham in 2011. She has published around 60 papers in international scientific journals and 30 book chapters and has supervised 19 PhD students to completion. Sanja was included in the prestigious Stanford University Top 2% Scientists Ranking in 2023.

Various Operational Research (OR) methods have been developed for all levels of decision-making in healthcare including strategic level, for example, capacity planning, location of facilities, services to be offered, facility layout, etc; tactical level, for example, supply chain management, equipment selection, financial allocation, staffing levels, etc; and operational level, for example, appointments booking, personal scheduling, inventory replenishment, quality monitoring, etc.

First, this talk will address scheduling problems in healthcare including well researched nurse rostering, myriads of appointments booking settings, scheduling of radiotherapy patients and junior doctor rotas. The focus will be on problems present in the healthcare institutions we collaborated with. The developed OR methods will be presented, formula free.

Data Science and Artificial Intelligence have started to dominate variety of sectors including healthcare. The role of data mining, especially some innovative ways of patients clustering we are developing, will be presented. The decision support in clinical work in radiotherapy planning, and the developed case-based reasoning systems will be discussed.

The talk will complete with insights into challenges that research with healthcare institutions may pose, and some directions for future research work.

Stochastic Vehicle Routing: an Overview

Professor Michel Gendreau

Plenary Speaker - Michel Gendreau, The Eric Sunderland LT, September 12, 2024, 15:10 - 16:15

Biography:

Michel Gendreau is Professor of Operations Research in the Department of Mathematics and Industrial Engineering of Polytechnique Montréal (Canada). His main research area is the application of operations research methods to a wide range of problem areas: transportation and logistics systems planning and operation, energy production and storage, healthcare, and telecommunications. Dr. Gendreau has published more than 400 papers in peer-reviewed journals and conference proceedings, as well as numerous book chapters. He is also the co-editor of eight books dealing with transportation planning and scheduling, as well as with metaheuristics.

Dr. Gendreau was the Director of the Centre for Research on Transportation (formerly CRT and now CIRRELT) from 1999 to 2007. He was Editor in chief of Transportation Science from 2009 to 2014 and has been a member of the editorial board of several other journals. A former President of the Canadian Operational Research Society, he was also Vice-President of the International Federation of Operational Research Societies (IFORS) from 2001 to 2003, from 2007 to 2009, and from 2013 to 2015, as well as Vice-President, International Activities of The Institute for Operations Research and Management Science (INFORMS) from 2006 to 2009.

In 2001, he received the Merit Award of the Canadian Operational Research Society in recognition of his contributions to the development of O.R. in Canada. He was elected Fellow of INFORMS in 2010 and became a fellow of IFORS in 2022. In 2015, Dr. Gendreau received the prestigious Robert Herman Lifetime Achievement Award of the Transportation Science & Logistics Society of INFORMS

While Vehicle Routing Problems have now been studied extensively for more than 60 years, those in which some parameters are uncertain at the time when the routes are designed have received significantly less attention, in spite of the fact that there are many real-life settings where key parameters are not known with certainty.

In this talk, the aim is to provide an overview of the main modeling strategies of Stochastic Vehicle Routing, with a focus on traditional VRP variants under uncertainty; our presentation is intended for newcomers to this topic as well as for researchers interested in references to the state-of-the-art. We first examine the main classes of Stochastic Vehicle Routing Problems: problems with stochastic demands, stochastic customers, and stochastic service or travel times. We then present the main approaches for modeling and tackling uncertainty: a priori models, a posteriori approaches, and chance-constrained models. We examine in detail models based on stochastic programming formulations, including the use of support- and scenario-based representations of uncertainty; we address compact, cut-based and route-based formulations, and comment on the

related solution approaches. We also discuss extensively the most common recourse policies, and their incorporation into formulations and solution methods.

This talk is based on a recent book chapter on “Vehicle Routing Under Uncertainty”, co-authored with Pedro Munari and Reinaldo Morabito of the Federal University of São Carlos, Brazil.

Presidents Address

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Novel, important, interesting, influential? About the fellowship of the Academy for the Mathematical Sciences

Ruth Kaufman

Presidents Address, The Eric Sunderland LT, September 10, 2024, 15:30 - 16:30

Biography:

Ruth Kaufman has worked in OR, and other senior management roles. in a number of different public sector organisations. She is a former President of the OR Society, a former Chair of the Government OR Service, and currently Chair of the ORS's Pro Bono Steering Group and the EURO Practitioners' OR Forum. She chairs the Governance and Fellowship workstream of the proto-Academy for the Mathematical Sciences, and is a trustee of the Academy CIO.

As ambitious plans for the Academy for the Mathematical Sciences (AcadMathSci) come closer to fruition, so too do plans for its Fellowship. The more people are aware of the plans, the better the chances of realising the vision of the Fellowship as a novel, important, interesting and influential grouping. The ORS has therefore invited this presentation, to help the OR community get up to speed with latest thinking.

The AcadMathSci has been founded as a National Academy with the aim of bringing together the whole of the mathematical sciences to develop, communicate, teach and use the power of the mathematical sciences to benefit our world. It will not replace the current well-populated landscape of organisations and individuals who currently contribute to this, but provide a structure to enable collaboration, coordination and synergy, and a voice to advocate and influence.

National Academies (the Royal Society, Royal Academy of Engineering, British Academy are the best-known UK national academies) are ultimately governed by their Fellowship. Fellow of the Royal Society (FRS), Fellow of the Royal Academy of Engineering (FREng) – these are people recognised by peers for the excellence of their work, and AcadMathSci Fellow status will be no different in that respect. Where it will differ is in the recognition of the great many dimensions of 'excellence', in the inclusion of people from across academia, practice, education, and in the intention to build a diverse and inclusive Fellowship from the outset.

Join this session to find out more about the Academy's plans for Fellowship, and where you can get involved.

Presidents Medal

Enhancing Fire and Rescue Services with the Dynamic Cover Tool (DCT).

Andrew Cooper, Tom Boness

ORH Ltd

President's Medal, The Eric Sunderland LT, September 11, 2024, 16:30 - 17:45

Biography:

Andrew has a wealth of experience working with emergency services, with particular emphasis on overseeing ORH's Dynamic Cover Tool (DCT). He manages implementations of the DCT and is responsible for its continuing development.

Andrew's previous professional experience and academic background in mathematics provided a good foundation in analysis and mathematical modelling. These skills have been further enhanced at ORH and are applied in solving complex service planning issues where he has also managed many consultancy projects for Fire and Rescue Services.

Andrew's experience at ORH includes:

- Overseeing the development of ORH's DCT
- Managing implementations of the DCT and maintaining ongoing relationships in an account manager role
- Optimising potential response locations and deployments in relation to demand coverage and targets
- Assessing alternative service delivery models in terms of the impacts to response performance and utilisation

Tom Boness is a software engineer at Operational Research in Health (ORH), where he specialises in writing simulation models of emergency services and non-emergency patient transport providers. Since joining ORH in 2013 Tom has worked on various simulation models and other software tools used by ORH and its clients – including the Royal Flying Doctor Service and New South Wales Ambulance in Australia, the Scottish Ambulance Service and East Midlands Ambulance Service in the UK.

In recent years, Tom has been responsible for engineering and implementing ORH's cloud-based Dynamic Cover Tool which is used in a number of fire and rescue service control rooms in the UK and overseas to help monitor their live service coverage and make informed decisions when moving and deploying resources.

Tom's fields of interest are discrete event and agent based simulation, and pickup and delivery problems. Tom holds a PhD in Theoretical Physics from University College London.

Operational Research in Health Limited (ORH) has developed the Dynamic Cover Tool (DCT) to support Fire and Rescue Services (FRSs) in optimising resource deployment and improving response times. This presentation will explore how the DCT provides a live, mapped display of resource locations and statuses, enabling data-driven decisions that effectively mitigate risk and enhance operational performance. Case studies from Surrey, Cleveland, and West Midlands FRSs will highlight the tangible benefits of the DCT, including improved response times, cost savings, and a shift towards evidence-based decision-making in high-pressure environments.

Using explainable AI to reduce risk and improve efficiency in GB electricity reserve.

Dr Kieran Kalair, Adam Brummitt

President's Medal, The Eric Sunderland LT, September 11, 2024, 16:30 - 17:45

Biography:

Dr Kieran Kalair is a leading expert in applying advanced mathematical and statistical techniques to tackle some of the most pressing challenges in the energy sector. With a PhD from the Mathematics of Real-World Systems Centre for Doctoral Training at The University of Warwick, Dr Kalair's early research focused on transforming transportation systems across the UK through data-driven methods.

Now a Principal Consultant at the Smith Institute, Dr Kalair brings a wealth of experience in optimising, forecasting, and applying data science to improve the efficiency, sustainability, and fairness of the electricity grid. His work has been pivotal in projects such as developing the dispatch optimiser for the Electricity System Operator (ESO), which ensures electricity generation meets demand with precision, and creating dynamic models for reserve requirements that safeguard grid stability. He has also contributed to modelling energy vulnerability, ensuring a just transition to a net-zero grid.

Dr Kalair is passionate about using the power of mathematics, statistics, and operational research to solve real-world problems, particularly those that shape a greener, more resilient energy future. His insights are not just about numbers; they're about making impactful decisions that drive societal progress.

To secure the British energy grid, it is vital that supply matches demand. Reserves of energy are held to ensure grid stability when forecast demands and supplies deviate from the actual values. However, holding too much energy in reserve can lead to unnecessary costs and inefficiencies.

This project focuses on improving energy grid stability and efficiency with Dynamic Reserve Setting (DRS). Collaborating with the Electricity System Operator (ESO), Smith Institute has developed an explainable AI model that dynamically recommends reserve holdings at a 30-minute resolution

based on real-time data and forecasts such as weather patterns, demand across the country, and flows of electricity between Britain and other European countries. These can be influenced by factors like major televised sporting events, heatwaves, or even just higher or lower than expected wind speed or cloud coverage.

Explainable AI is key for ESO, allowing engineers to understand and trust the AI's recommendations, ensuring they can confidently manage reserve levels in real-time.

Towards Sustainable Agricultural Production and Waste Management in Vietnam

Trung Hieu Tran, Dr ThuBa T. Nguyen

President's Medal, The Eric Sunderland LT, September 11, 2024, 16:30 - 17:45

Biography:

Dr Tran is Lecturer in Data Analytics and leads Data-driven Innovation Community of Practice and Digitalisation Innovation theme at Centre for Design Engineering (C4DE), Cranfield University. His research interests focus on the theory and application development of advanced Data Analytic methods (including mathematical programming, metaheuristic algorithm, artificial intelligence, agent-based modelling and simulation) for solving NP-hard optimisation problems in manufacturing and service, as well as global challenge issues. He has been PIs and Co-Is for several FCDO, EPSRC, British Academy, Research England, and Boeing funded projects. He has published two book chapters and more than 25 scientific articles in top-ranked journals in Data Analytics and Optimisation. He is experienced in large-scale network modelling and optimisation to mitigate against disruptions (e.g., unexpected attacks, break-down and failures) in public transport, hub-and-spoke, fuel-station networks and gas transmission. These works have led to increasing resilience for MRT network in Singapore, for road infrastructure systems in Vietnam, and for National Grid's gas transmission network in UK under risk of disruptions.

Dr Nguyen is Lecturer in Business Analytics at University of Bedfordshire. She achieved PhD degree in Operational Research in the Singapore-MIT Alliance programme. Her research focus on mathematical programming models for healthcare system improvement, vehicle routing models and algorithms, manufacturing operation efficiency and robust optimisation. She has been the Co-I for FCDO funded project that builds sustainable agricultural waste management model at the Mekong Delta. She has published several scientific articles in the top-ranked journals of Operational Research.

This project addresses the challenges of sustainable agricultural production and waste management in Vietnam by studying a novel location-assignment-routing problem (LARP) influenced by climate change. They have developed an innovative mixed-integer nonlinear programming model, which was transformed into a linear form using a linearisation technique,

enabling solution by general-purpose solvers. Additionally, a parallel water flow algorithm was designed to efficiently solve large-scale instances. The proposed solution was successfully implemented in Quang Tri province, demonstrating its effectiveness in optimising agricultural waste collection and transport networks.

Artificial Intelligence and Machine Learning

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A Multilayer Network Approach to Text-Based and Citation-Based Similarity Analysis among Legal Judgements

Mr Kumar Sarthak¹, Dr Shaurya Shriyam, Dr Nomesch Bolia

Indian Institute Of Technology Delhi

Parallel 1 - AI & Machine Learning (2), The R.Willims Parry (OSCRA), September 10, 2024, 10:30 - 12:00

Biography:

Kumar Sarthak is pursuing his PhD at Indian Institute of Technology, Delhi. His research interests involve network analysis and ontology development.

We provide a graphical framework to incorporate the metadata of legal judgements with an objective to compute the similarity between two legal judgements. The task of finding similar judgments assists legal practitioners to retrieve prior judgments relevant to the present case. A legal judgement is an extensive textual document which comprises of numerous legal concepts. Existing research has proposed citation-based and textual-based methods for measuring the similarity between legal judgements. In our work, we model legal judgements as a multi-layer network, which is an appropriate representation of directed acyclic graphs (DAGs). Additionally, to overcome the computational limitations of the legal citation network due to its sparsity, it is represented as a multiplex of dense graphs. In this network, the layer depicts the textual-based similarity, which is analyzed on the paragraph-level using neural network models, and the edges between the nodes in each layer are formed based on commonality in citations among the judgements. For this study, we curate a large dataset of judgements on land acquisition from the Supreme Court of India. Our analysis shows that the combined methodology of citation-based, and textual-based similarity performs superior to several state-of-the-art similarity models. In contrast with traditional approaches, a multi-layer representation provides a deeper understanding of the nuanced dynamics within the real-world dataset. We conclude that this demonstration provides a finer look at the similarity of legal judgements through the lens of multi-layer networks. This study is the first of its kind to efficiently unify the two methods of similarity analysis in a graphical network, and also to learn insights through the visual embedding of similar judgements.

Predicting Part Consumption for Aircraft Maintenance

Dr Jessica McQuade

Datasparq

Parallel 1 - AI & Machine Learning, Greek Room, September 10, 2024, 10:30 - 12:00

Biography:

Jessica McQuade is a consultant data scientist working at Datasparq. She received her PhD in Computational Biophysics from Imperial College where her research focussed on the rules of stable pattern formation in the single cell. Following her studies she worked as an Operational Researcher in the Civil Service. Moving closer to her interest in complex systems and emergence she took a role as a data scientist at Epistemix, where she developed Agent-Based models to describe dynamic systems in a range of contexts; commercial, epidemiological, social and operational. She currently works on applying Machine Learning and simulation techniques to solving operational problems in industry.

In aviation, as in other industries, predictive models can be applied to a range of complex situations in order to make quantitative assertions about future events. In this work we apply tree-based algorithms to a general maintenance forecasting problem based in the aviation sector. Can we predict where replacement part consumption will occur and stock will be needed?

Accurate predictions of stock consumption enable airlines to be resilient to unplanned maintenance events caused by part failure during connected flight routes. If a part is not available at a key location in the network to replace a faulty component, so-called aircraft-on-ground events occur which can lead to financial loss, flight delays, cancellations, and in turn loss to brand perception. With a complex system of parts, planes, routes and the environment how do we identify the principal - and crucially, viable - aspects of stock consumption to model? This work moves beyond the rare-event modelling of time-to-failure distributions and the routine of scheduled maintenance, instead taking a data-driven holistic description of part consumption to better capture unplanned maintenance events.

Motivating our approach we discuss historic and current statistical approaches to predicting part consumption - covering the limitations of an historic average and the infeasibility of time-to-failure approximation. We develop a feature space by combining real-world stock and flight data from a major airline with geographic and environmental external data sources. Applied to a real-world context the usability of model predictions is paramount and coupled to model suitability.

Predictions must fit into current working processes, often which are disseminated across multiple business areas. We discuss operational limitations and the place of discussions with subject matter experts in model design and ensuring model results can fit into current business processes. To this end, we generate part consumption predictions for a global network of airports on a monthly and seasonal basis. Finally, we share ideas for future direction and model improvements - including

segmentation approaches to better categorise within-part behaviour and the implementation of an asymmetric loss function to better emulate real-world consequences of inaccurate predictions.

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Real-Time Optimisation of Micro-grids Using TD3 and Deep Reinforcement Learning: Southeast Asia

Mrs Yara Jubran

Durham University

Parallel 1 - AI & Machine Learning, Greek Room, September 10, 2024, 10:30 - 12:00

Biography:

Yara, a researcher and educator specializing in data-driven solutions in AI and machine learning, is currently pursuing a PhD at Durham University. Her research centers on optimizing renewable energy systems in developing countries using advanced data science and machine learning methodologies. With over 13 years of experience in Research and Analytics Consulting, she is an expert in data management, big data analytics, and business intelligence. Yara actively collaborates with academia and industry on projects aimed at addressing real-world challenges, particularly in sustainable development and societal well-being.

In this study, we examine the integration of the Twin Delayed Deep Deterministic (TD3) algorithm for the real-time optimization of solar microgrids, specifically focusing on Southeast Asia. The transition from hourly to minute-level optimization, utilizing a detailed dataset, represents a significant leap towards improving the efficiency and reliability of solar microgrid energy distribution. This research underscores the TD3 algorithm's capacity to finely balance the supply and demand of energy, showcasing notable advancements in operational efficiency, fuel consumption reduction, and the prevention of blackouts in islanded microgrid environments. Through an extensive analysis involving factorial experiments and computational simulations, the paper demonstrates the TD3 algorithm's pivotal role in promoting sustainable energy management practices. The findings highlight the algorithm's scalability and its potential as a solution for the efficient management of microgrids in remote and island communities, thereby setting new standards in the application of deep reinforcement learning for real-time energy system optimization. This work not only contributes to the discourse on renewable energy management but also establishes benchmarks for future research in the field, emphasizing the importance of advanced optimization techniques in enhancing the sustainability and reliability of solar microgrids.

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A Distributionally Robust Optimisation Approach to Fair Credit Scoring

Mr Pablo Casas, Dr Huan Yu, Prof Christophe Mues

University of Southampton

Parallel 1 - AI & Machine Learning (2), The R. Willims Parry (OSCRA), September 10, 2024, 10:30 - 12:00

Biography:

Pablo Casas is a third-year PhD student at the University of Southampton and a model risk analyst at WiZink Bank. His research focuses on fair machine learning in Credit Scoring under uncertainty and data shifts. Before enrolling on his PhD, he did an MSc in Intelligent and Adaptive Systems at the University of Sussex, where he focused on complex systems and long-range temporal correlation in brain oscillations and a BSc in Economics at the Complutense University of Madrid. Optimization under uncertainty has been a topic of large debate in Operations research (OR) and Machine Learning (ML) communities for a long time. Recently, many authors have turned to distributional robust optimization (DRO) in search of a solution; however, fewer studies have focused on enhancing fairness under uncertainty. This is of great interest in those applications of ML that can have a direct damaging impact on the population, credit scoring (CS) being one of the most potentially damaging fields according to regulatory bodies.

The paper presented explores the effects of using a DRO-based logistic regression (LR), one of the most commonly used classifiers in CS, across multiple CS datasets. This study will show how robustness has a greater impact on fairness than the fairness constraint, and that the impact on performance is negligible and, in some datasets, positive. We will also provide an empirical analysis of the effect of the different hyperparameters that are unique to DRO-based LR. Furthermore, we will argue that the level of robustness narrows the dispersion of the probability of default distribution and that the parameters in charge of the ground metric have an unnoticeable impact. On a side note, we suggest traditional fairness metrics used in credit scoring are not best suited for the task.

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Generative Artificial Intelligence Tools to Enable More Efficient Business Intelligence

James Kainz, Mark Espinoza

ARA

Parallel 1 - AI & Machine Learning, Greek Room, September 10, 2024, 10:30 - 12:00

Biography:

James Kainz is a Senior Vice President and Director of Corporate Business Development at ARA. In this role, Mr. Kainz guides strategic planning and ARA corporate initiatives to help ARA grow and bring next generation innovation and technologies to our customers and stakeholders. Mr. Kainz is licensed Professional Engineer. He completed his M.S in Civil Engineering at the University of Wisconsin – Madison and his B.A. in Business Administration at St. Mary's University.

Use of generative artificial intelligence (GenAI) tools has become ubiquitous across multiple disciplines. In business development and market forecasting, GenAI shows great promise to discover trends, capture unknowns, and ease the burden of and scale output for business development personnel. Many factors influence the use of GenAI tools and the business community currently has access to many off the shelf solutions. However, when working with propriety and business-sensitive data, several important development criteria come into play. The criteria include ensuring security of the data, establishing governance measures of the GenAI solution(s) (e.g. access criteria and use limitations), as well as appropriately scaling the application to meet specific requirements. GenAI solutions are evolving at a rapid pace and we already see real use cases where GenAI implementation has already changed the landscape – adoption of GenAI tools are critical to keeping a competitive edge. In many instances, it becomes necessary to make tradeoffs when adopting technologies, particularly when operating as a practitioner. This serves as a preliminary step towards developing a comprehensive business intelligence (BI) solution that fulfills the organization's needs. By carefully considering and balancing factors, practitioners can lay the foundation for effectively leveraging technologies to meet their BI requirements.

In this presentation, we will discuss the benefits, challenges, and potential pitfalls of implementing a GenAI solution to augment BI tools using proprietary data. We will also discuss the need to maintain a “practitioner” mindset as well as “developer” role to take advantage of changing technologies and market forces.

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Fairness stability of credit scoring models and Explanation variation.

Mr Pablo Casas, Dr Huan Yu, Prof Christophe Mues

University of southampton

Parallel 2 - AI & Machine Learning, LR5, September 10, 2024, 13:00 - 14:00

Biography:

Pablo Casas is a third-year PhD student at the University of Southampton and a model risk analyst at WiZink Bank. His research focuses on fair machine learning in Credit Scoring under uncertainty and data shifts. Before enrolling on his PhD, he did an MSc in Intelligent and Adaptive Systems at the University of Sussex, where he focused on complex systems and long-range temporal correlation in brain oscillations and a BSc in Economics at the Complutense University of Madrid.

The issues with ML fairness and stability in the presence of shifts are commonly found in the literature. However, few studies look for variable-level stability, which to our understanding can offer very useful insights for practitioners. In the particular context of credit scoring, the ML model has to take the form of a scorecard which need to be explained to both the creditor and the regulator, preventing those scorecards to be constantly updated. Hence finding the ideal time to rebuild the scorecard becomes a relevant and sensitive matter for both the creditor and the regulator.

To allow a model to be applied in real credit scoring setting, the regulator needs to assess several aspects such as whether it performs in a rational, explainable and fair manner or whether its stability holds over time. However, more complex ML systems make these aspects harder to observe and validate. Often, the lack of explainability is solved using Shapley values, yet this method can present a lack of stability.

Upon these circumstances, this working paper aims to study whether Shapley stability relates to the model's performance and fairness over time and so if that relation can be exploited to obtain early indicators of shift.

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Enhancing Credit Risk Assessment with Dynamic Clustering and Multi-Armed Bandit Algorithms

Mr Sarthak Gurnani, Dr Huan Yu

University Of Southampton

Parallel 2 - AI & Machine Learning (2), Welsh Seminar Room, September 10, 2024, 13:00 - 14:00

Biography:

Sarthak is currently pursuing a Ph.D. in Reinforcement Learning and Credit Risk. He holds a B.Sc. in Finance from NMIMS, India, an International Masters in FinTech from Politecnico Di Milano, Italy, and an M.Sc. in Business Analytics and Finance from the University of Southampton.

Customer credit assessment is a key process wherein a lender has to decide to whom the loan should be granted based on various factors such as credit history, occupation, age, and other financial and personal characteristics. This complex decision-making process involves analysing extensive data to evaluate the risk of default and determine the creditworthiness of potential borrowers since it impacts the financial health of the lender based on the performance of the loan portfolio. In a bid to enhance this process, financial institutions are increasingly leveraging advanced data analytics and machine learning algorithms. For this purpose, this paper presents a framework that predicts the probability of default and sequentially selects customers to whom the loan should be granted. Initially, a neural network categorizes customers into clusters based on their probability of default. And then a Multi-armed Bandit (MAB) model selects a customer at

each timestep by pulling an arm, where pulling an arm is the same as granting a loan and each arm represents a cluster of customers with unique and separable reward distributions. The agent's objective is to maximize the cumulative reward and ultimately the overall profit of lender. This is tested through four MAB algorithms (Greedy algorithm, Epsilon Greedy algorithm with Epsilon as 0.1 and 0.01, Upper Confidence Bound with C as 1 and 2 and Thompson Sampling) on a real-world dataset relating to customer credit risk. The best performing online MAB algorithms are then compared with an offline model, Logistic Regression, and have proven to generate higher profits than the offline model and the actual profits.

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Assessing the Efficacy of AI in Transforming Risk Management in the AEC Industry

Dr Manu Ramegowda, Mr Babtunde Adabiri, Dr M.K.S. Al-Mhdawi
Teesside University

Parallel 2 - AI & Machine Learning (2), Welsh Seminar Room, September 10, 2024, 13:00 - 14:00

Biography:

Babatunde Adabiri is a postgraduate student in project management at Teesside University. He holds a bachelor's degree in civil engineering from the University of Ilorin. His current research work involves validating the use of artificial intelligence tools in risk management, focusing on the architectural, engineering, and construction industry.

In South Asia, the architectural, engineering, and construction (AEC) sector has experienced significant growth, achieving a 6.2% increase between 2019 and 2023. Despite these advancements, the industry continues to face persistent risks such as frequent project delays and quality deficiencies. Amidst these issues, there is a strong interest in adopting artificial intelligence (AI) among construction firms, with 92% expressing a desire to implement AI technologies. However, integrating AI into existing infrastructures presents major challenges. Nonetheless, the potential for growth in the AI market is substantial, projected to rise from \$530 million in 2023 to \$27.27 billion by 2031, indicating a trend towards broader AI adoption within the sector. Given the complexity and unpredictability of AEC projects, there is an urgent need for enhanced risk management processes. While traditional frameworks like ISO 31000:2015 offer valuable guidelines, they often fall short in addressing the dynamic nature of AEC projects. As a result, AEC stakeholders are increasingly recognising the necessity for a more comprehensive approach to risk assessment that can accommodate both foreseeable and unforeseeable risks. To this end, the aim of this research is to investigate the efficacy of AI tools in enhancing the risk management processes within the AEC industry. The methodology included a review of existing risk-based AI literature, followed by a comparative case study that evaluates traditional risk management processes against the outputs from AI tools such as Jeda AI® and Gemini®. The findings of this research indicated that AI tools significantly enhance risk identification and qualitative-based risk

analysis and response. However, these tools exhibit limitations when applied to quantitative-based risk analysis. The observed inconsistencies in data analysis indicate that although AI can automate and refine certain aspects of risk assessment, human oversight remains crucial, emphasising the necessity for a balanced integration of AI tools and human expertise to ensure effective management of risk.

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Human-AI collaboration to mitigate decision noise in financial underwriting: A study on FinTech innovation in a lending firm

Dr Fatima Almaghrabi¹, Dr Swati Sachan², Prof Jian-Bo Yang³, Prof Dong-Ling Xu³
Umm Al-Qura University, ²The University of Liverpool, ³The University of Manchester
Parallel 2 - AI & Machine Learning, LR5, September 10, 2024, 13:00 - 14:00

Biography:

Fatima Almaghrabi is an Assistant Professor of Operations Research and Decision Sciences and the Head of the Tourism and Hospitality Department at the School of Business and Economics at Umm Al-Qura University. She has a multi-disciplinary background with degrees in management information systems, operations management, and operations research. Her research focuses on developing AI tools for creating better decision support systems.

Financial institutions have recognized the value of collaborating human expertise and AI to create high-performance augmented decision-support systems. Stakeholders at lending firms have increasingly acknowledged that plugging data into AI algorithms and eliminating the role of human underwriters by automation, with the expectation of immediate returns on investment from business process automation, is a flawed strategy. This research emphasizes the necessity of auditing the consistency of decisions (or professional judgment) made by human underwriters and monitoring the ability of data to capture the lending policies of a firm to lay a strong foundation for a legitimate system before investing millions in AI projects. The judgments made by experts in the past re-emerge in the future as outcomes or labels in the data used to train and evaluate algorithms. This paper presents Evidential Reasoning-eXplainer, a methodology to estimate probability mass as an extent of support for a given decision on a loan application by jointly assessing multiple independent and conflicting pieces of evidence. It quantifies variability in past decisions by comparing the subjective judgments of underwriters during manual financial underwriting with outcomes estimated from data. The consistency analysis improves decision quality by bridging the gap between past inconsistent decisions and desired ultimate-true decisions. A case study on a specialist lending firm demonstrates the strategic work plan adapted to configure underwriters and developers to capture the correct data and audit the quality of decisions.

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Agent, catalyst, or apocalypse? Engaging analytical challenges using Large language models

Dr Libo Li

University Of Southampton

Parallel 3 - AI and Machine Learning, LR5, September 10, 2024, 14:10 - 15:10

Biography:

Libo is a Lecturer in Business analytics at Southampton Business School, University of Southampton. Libo's research interests are social network analytics, data mining, machine learning, and statistical modelling. His research appears in academic outlets and conferences including computer networks, IEEE Transactions on Engineering Management, European Journal of Operational Research and the International Conference on Information Systems. Libo serves as an ad hoc reviewer for several journals and conferences, such as ICIS, ECIS and Innovations in Systems and Software Engineering.

Large language models (LLMs) are increasingly becoming tools to assist in business analytics and data science tasks. They offer advice in question-and-answer sessions on topics such as computer programming, mathematics, and the interpretation of analytical results. While using LLMs in practice to aid analytical tasks can conveniently provide explanations for difficulties and explore potential solutions, there is often concern about the reliability of the answers provided, known as artificial intelligence hallucination. This raises questions about the reliability of LLMs in supporting analytical tasks and highlights the risk of adopting such practices.

Given the opportunities and challenges ahead, this work focuses on various scenarios involving user engagement with LLMs for data science and analytical tasks. We review the support mechanisms LLMs could possibly provide and critically examine the pitfalls as well as potential remedies in these scenarios. Understanding the interaction with LLMs enables organizations to assess the risks and benefits before adopting LLMs in their analytical solutions.

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Generative AI in Credit Scoring

Dr Huan Yu

Southampton Business School

Parallel 3 - AI and Machine Learning, LR5, September 10, 2024, 14:10 - 15:10

Biography:

Dr Huan Yu is a Lecturer in Business Analytics within Southampton Business School at the University of Southampton.

In recent years, the integration of generative artificial intelligence (AI) techniques in credit scoring has garnered significant attention from both academia and industry. This study provides a comprehensive overview of the application of generative AI in credit scoring, summarizing key methodologies, challenges, and potential benefits.

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New Heuristics for Vector Scheduling

Dr Lars Nagel

Loughborough University

Poster Presentations, The Eric Sunderland LT, September 11, 2024, 11:00 - 12:00

Biography:

Lars Nagel is a lecturer at Loughborough University. He received his diploma in Computer Science from the Technical University of Munich and his PhD from Durham University for his studies of randomised load balancing processes. He worked as a software developer for Trium and Siemens and was a postdoctoral researcher at Paderborn University and Mainz University. His main research interests are combinatorial optimisation, random processes, algorithm design and analysis, and distributed systems.

Vector scheduling and vector bin packing are fundamental problems in operational research, involving the packing of a set of vectors or items into a fixed set of bins or a minimum number of bins such that the sum of the vectors in each bin does not exceed the bin's vector capacity. Applications include packing physical boxes under weight and volume constraints or scheduling virtual machines in cloud computing, where the resource requirements of the virtual machines and the resource capacities of the physical machines can be modelled as items and bins. Since vector scheduling and vector bin packing are NP-hard, no efficient exact algorithms are known. For that reason, several heuristics have been devised that can be applied to larger instances but do not guarantee good packing results.

We present a set of new heuristics optimized for different scenarios. A multi-bin algorithm is so fast that it can be applied in any time-critical application. A bin-centric linear search algorithm is slower by an order of magnitude but computes considerably better results on average. Finally, a heuristic applying techniques from linear programming is comparatively slow but achieves optimal or near-optimal results. The new heuristics are compared to many algorithms from the literature. Experimental results show that the new approaches pack items better than algorithms of similar speed from the literature.

Some of the research presented is from paper published in the proceedings of the "17th Learning and Intelligent Optimization Conference" (LION) in 2023.

Combinatorial Optimisation

How to design a serial knockout competition

Frits Spieksma

Parallel 6 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 11, 2024, 13:30 - 15:00

Biography:

Frits Spieksma is a Full Professor at Eindhoven University of Technology (TU/e). Frits is particularly interested in various scheduling, routing, and clustering problems. He is especially interested in sport scheduling, kidney exchange models, combinatorial auctions, and logistic challenges. These problems are connected to computer science, discrete mathematics, (applied) economics, management science, and indeed, he has great interest in problems that are in the intersection of other scientific disciplines and combinatorial optimization.

He has supervised more than 15 PhD students. He is founder of the EURO Working Group OR in Sports, which aims to bring together quantitative research related to sport. He is President-Elect of EURO. He is also a member of the organizing committee of MathSports International, which brings together mathematics and sports

We investigate a new tournament format that consists of a series of individual knockout tournaments; we call this new format a serial knockout competition (SKC). This format has recently been adopted by the Professional Darts Corporation. Depending on the seedings of the players used for each of the knockout tournaments, players can meet in the various rounds of the knockout tournaments. Following a fairness principle of treating all players equal, we identify an attractive property of an SKC: each pair of players should potentially meet equally often in each of the rounds of the SKC. If the seedings are such that this property is indeed present, we call the resulting SKC stable. We show that stable SKCs exist for any numbers of players that are a power of two.

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Dynamic Real-Time Orienteering for Election Campaigns:

Predictive-Model-Agnostic Online Optimization for Selective Campaign Activities

Davood Shiri¹, Masoud Shahmanzari², Fehmi Tanrisever³

¹Sheffield University Management School, ²Brunel Business School, ³Bilkent University

Parallel 6 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 11, 2024, 13:30 - 15:00

Biography:

Dr Davood Shiri is a Lecturer in Operations Management and Decision Sciences at Sheffield University Management School, University of Sheffield, United Kingdom. His research focuses mainly on online and stochastic optimization, large-scale optimization, graph and network models, healthcare and humanitarian logistics and combinatorial optimization. He is the author of many scientific papers published in peer-reviewed journals in Operations Research. Davood gained his BSc and MSc in Industrial Engineering at Sharif University of Technology, Iran. He holds a PhD in Industrial Engineering and Operations Management from Koc University, Turkey.

The landscape of campaign management has undergone a profound transformation with the introduction of data collection and analysis technologies. This shift, facilitated by real-time data and predictive analytics, has revolutionized practices across various domains, including electoral politics, advertising, and disaster relief efforts. In the realm of electoral politics, presidential candidates strategically organize their activity calendar by utilizing predictive models to estimate the impact of alternative campaign activities on their chances of winning the election. These predictions rely on a multitude of factors, including historical data, real-time information, and pertinent features such as demographic data, historical election trends, socioeconomic indicators, issue importance, media sentiment, and competitor analysis. It's essential to recognize that these predictions are dynamic. As new data becomes available or the campaign progresses, the predictions are continuously updated and refined to reflect the evolving circumstances and changing dynamics of the election. This dynamic nature of predictions empowers campaign planners to adjust their strategies in real-time and optimize their efforts based on the most current information and insights available. Given that the accuracy of predictive models cannot be measured without access to perfect information and considering that each political party may employ its own predictive models to guide campaign activities of their candidate, we propose a predictive-model-agnostic online optimization method to optimize the campaign activities of the candidate in real-time. Our theoretical contribution involves proposing various deterministic and randomized policies with worst-case performance guarantees. To empirically validate our results, we examine a real-life application of our proposed online optimization methodology to election logistics, using the most recent US presidential elections as a case study. Our simulations demonstrate that employing properly randomized online algorithms can significantly enhance the empirical performance of such algorithms, thereby maximizing the chances of victory in the election.

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Exact Algorithms in Bar Nesting: How to Cut Items with Angled Sides from Linear Stocks

Professor Rhyd Lewis
Cardiff University

Parallel 7 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 09:00 - 10:30

Biography:

Rhyd Lewis is a professor in mathematics. He is the author of the book *A Guide to Graph Colouring: Algorithms and Applications*. He has a PhD from Edinburgh Napier University (2006), and a BSc (hons) in Computer Science from Swansea University (2002).

This presentation will present some exact, polynomial-time methods that address the challenge of cutting items with angled sides from a single linear stock while minimizing wastage. This is a problem often termed as "bar nesting" in industry. Here, we will outline an algorithmic framework capable of solving various important variations of the problem. These include cutting items from stocks with asymmetric cross-sections, cutting items whose sides occur on different planes, and addressing the minimum score separation problem. Some of our techniques have been used in the development of commercial software such as Top Solid Design and AutoBarSizer.

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Improving Route Planning of Electric Vehicles by Considering Road Gradients and Regenerative Braking

Dr Merve Keskin, Dr Sina Rastani, Dr Tuğçe Yüksel, Prof Bülent Çatay
1Sheffield University Management School

Parallel 7 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 09:00 - 10:30

Biography:

Merve is a lecturer in Operations Management and Decision Sciences at Sheffield University Management School. Her research interests include modelling optimisation problems, especially related to logistics operations, and applying operational research methodologies to solve them. With the increasing greenhouse gas emissions, the use of electric vehicles (EVs) in logistics has increased. In contrast to conventional vehicles, EVs use batteries to store energy, and they often stop at stations to recharge. The energy consumed per unit distance traveled depends on several factors including vehicle load, speed, and road gradient.

Traversing an arc with a positive gradient requires more energy compared to an arc on a flat network. This is further amplified when the EV carries a heavy load while moving uphill. Conversely, if the driver presses the brake pedal to maintain a constant speed while moving downhill, it can regain energy through regenerative braking technology. The impact of road gradients and regenerative braking may be significant for companies that carry heavy loads in hilly regions. Therefore, an approach that incorporates both cargo weight and road network terrain may improve the route planning of EVs. With this aim, this study addresses an extension of the

Electric Vehicle Routing Problem with Time Windows considering a comprehensive energy consumption function that incorporates the cargo load, road gradient, and regenerative braking. We formulate the problem as a mixed integer linear program and solve small-size instances with Gurobi. Numerical results show that considering the road gradient along with the cargo weight can significantly influence the routing decisions.

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Multi-Objective Covering Location Problems with advanced connectivity features and zonal requirements: Exact and Matheuristic approaches

Dr Serena Fugaro, Prof Antonino Sgalambro

Parallel 7 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 09:00 - 10:30

Biography:

Dr Serena Fugaro is a postdoctoral researcher at the Institute for Applications of Calculus "Mauro Picone" of the National Research Council of Italy since July 2021.

Her main research interests are in the area of Operational Research and Combinatorial Optimisation, with a focus on network optimisation, multi-objective optimisation, location analysis and supply chain network design. She is also involved in technology transfer activities.

Dr Fugaro obtained her PhD in "Mathematics and Applications" at the University of Naples "Federico II" in September 2021 with a thesis on three variants of the Shortest Path Problem, which was awarded the Best AIROYoung Dissertation Award 2022. During her PhD, she spent three months as a visiting researcher at the LIX laboratory of the École Polytechnique of Paris-Saclay, (Palaiseau, France), working on the design of 3D trajectories for flying vehicles, with and without a driver.

Dr Fugaro was among the laureates selected to attend the EURO Summer Institute on Location Science 2022, at the University of Edinburgh (Edinburgh, Scotland), and she was also selected by the EURO WISDOM Forum (Women In Society: Doing Operational research and Management Science) as a role model for young women in OR in 2023.

Dr Fugaro recently spent two weeks as a Visiting Researcher at the Sheffield University Management School (Sheffield, UK) where she gave an invited seminar for the OMDS Sustainable Production and Consumption theme.

Real-world facility location problems often demand to tackle simultaneously zonal requirements and facility interconnection issues; these may arise from administrative, managerial and operational needs, aiming to ensure an equal distribution of services, while concurrently securing an efficient flow of goods, people or information among the located facilities. As the literature

appears rather limited in addressing this challenge, in this work [1] we bridge such a gap by exploring the integration of the Maximal Covering Location Problem with spatial-related requirements and advanced connectivity features. We adopt a broad modelling perspective, accounting for structural and economic aspects of these connectivity attributes, while allowing for the choice of one or more depots to serve and feed the networks of located facilities, and containing the maximal distance between any located facility and such depots. Under these modeling assumptions, the objectives to be fulfilled are multiple and mutually conflicting. To enhance decision-making in this scenario, we introduce a novel class of Multi-Objective Covering Location problems, prove their NP-hardness, and devise original MILP models for their mathematical formulations. To efficiently explore the corresponding Pareto Sets, we adapt the robust version of the AUGMENTED ϵ -CONstraint method [2]. Additionally, to allow its scalability, we integrate this scheme with a Matheuristic procedure, designed by exploiting the mathematical properties for the introduced problems.

We conduct a comprehensive computational study on benchmark instances adapted from the extant literature on Location Problems with interconnected facilities and Clustered Shortest Path Problems. The experiments provide a proof of concept for the proposed models and highlight the challenging nature of the advanced connectivity features, particularly in the presence of multiple depots. Both approaches give a thorough approximation of the relevant Pareto Sets for medium-sized problems, while the Matheuristic shows a highly scalable performance when tackling large-sized instances and multiple depot configurations.

References

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- [2] Nikas, A., Fountoulakis, A., Forouli, A., & Doukas, H. (2020). "A robust augmented ϵ -constraint method (AUGMECON-R) for finding exact solutions of multi-objective linear programming problems." *Operational Research*, 1-42

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Integrating Machine Learning algorithms and Cluster-First Route-Second Approach for Real-Time Optimisation of Green Vehicle Routing Problem (GVRP)

Dr Azar Mahmoudgonbadi¹, Dr Mahnaz Hosseinzadeh², Professor Francisco Saldanha-da-Gama²
¹University Of Greenwich, ²University of Sheffield

Parallel 8 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 11:00 - 12:30

Biography:

Azar, with a background in industrial engineering, has recently taken on the role of Lecturer in Business Operations and Supply Chain Management at the University of Greenwich. Her PhD thesis focused on the development of a mathematical modelling toolkit aimed at accelerating the shift towards a Circular Economy. Her research has received funding from the European Commission's Horizon 2020 research and innovation programme under the following projects: Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE project); H2020-SC5-2020-2 scheme, Grant Agreement 101003491 (JUST2CE project).

This paper proposes a novel framework for addressing challenges in urban freight transportation, focusing on dynamic traffic conditions, environmental sustainability, and efficient cold supply chain management. Integrating real-time traffic data, machine learning, and a cluster-first route-second approach, the framework optimises large-scale vehicle routing problems (VRPs) in cold supply chains. Firstly, it integrates real-time traffic data using machine learning technique to adaptively adjust routes, minimising delivery times and reducing environmental impact. Secondly, it extends green vehicle routing models to accommodate time-dependent constraints in cold supply chains, ensuring the timely delivery of temperature-sensitive goods. Lastly, it adopts a cluster-first route-second methodology to enhance scalability, reducing the complexity of VRPs in dense urban environments. This framework contributes to urban freight management by providing a comprehensive approach to real-time optimisation, addressing time-dependent routing challenges, and offering scalable solutions for large-scale VRPs. Through these advancements, the research aims to promote more efficient and sustainable supply chain operations in urban settings.

Keywords: Machine Learning algorithm, Cluster-First Route-Second Approach, Green Vehicle Routing Problem (GVRP)

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Application of Transfer Learning to Deep Reinforcement Learning for Combinatorial Optimization

Dr. Fatima Ezzahra Achamrah

University Of Sheffield

Parallel 8 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 11:00 - 12:30

Biography:

Fatima Ezzahra Achamrah is a Lecturer in Operations and Supply Chain Management at Sheffield University Management School, University of Sheffield, United Kingdom. Fatima Ezzahra holds a Ph.D. in industrial engineering from Paris Saclay University, CentraleSupélec, France, and an

engineering degree (MEng/CEng) in process engineering from the National School of Applied Sciences.

Before joining the Management School, Fatima Ezzahra worked as a postdoc researcher at the Centre for Management Science of Mines Paris - PSL University, France, and as an R&D Engineer at HEC Liège, Ecole Centrale Casablanca, and GE.

Her research interests are at the forefront of the intersection between operations research and machine learning, particularly focused on combinatorial optimization problems. She employs an interdisciplinary approach that integrates advanced AI techniques, such as reinforcement learning, with both exact and meta-heuristic methods. This enables her to tackle complex challenges in diverse areas, including vehicle routing, inventory routing, selective maintenance, and 3D bin packing problems. A significant aspect of her work also involves delving into flow and disruption management within cyber-physical networks, with a special emphasis on the ground-breaking concept of the 'Physical Internet'.

Traditional optimization methods struggle with the inherent uncertainties of Combinatorial Optimization Problems (COPs) that have become increasingly apparent in recent years. While effective in deterministic settings, these methods lack the flexibility and adaptability needed for real-world COPs.

Deep Reinforcement Learning (DRL) offers a promising solution for dynamic decision-making within these complex environments. However, applying DRL to COPs faces limitations. Generalizing across various problem instances without extensive retraining or customization for each new variant proves challenging, leading to significant computational costs and inefficiencies.

This paper addresses these challenges by introducing a novel framework that combines the strengths of DRL (adaptability and learning) with Transfer Learning (TL) and Neural Architecture Search (NAS) to improve efficiency. This framework allows leveraging knowledge gained from solving COP/s to improve solutions for different but related COP/s. This eliminates the need to retrain models from scratch for each new problem variant, significantly reducing computational costs.

The framework's effectiveness was evaluated on over 1,500 benchmark instances across 10 stochastic and deterministic variants of the Vehicle Routing Problem (VRP). These variants included VRP with time windows, VRP with pickup and delivery, electric VRP, and two-echelon VRP. Compared to state-of-the-art algorithms (exact, metaheuristics, and other RL-based methods), the experimental results demonstrate the framework's superior performance in both solution quality and computational efficiency.

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Using OR to Solve the e-waste Problem

Sheeba Pathak, Dr. Wolfgang Garn, Dr Christopher Turner
Surrey Business School

Parallel 9 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 13:30 - 15:00

Biography:

A present doctoral researcher and a professional in the Supply Chain Strategy & Operations Excellence domain with rich in-depth experience in the automotive sector, logistics and e-commerce; using the research principles of Six Sigma statistics, lean & design thinking apart from applied OR techniques with demonstrable results & recommendations that drive profitability & turn-around of O&SCM business' transformations.

e-waste is a multi-billion dollar industry, consequently its volume does and thus its proper management which includes collection, processing and disposal is key towards minimising space apart from costs, time and even greenhouse emissions.

This paper, builds on previous works of emissions used as a weight in the network flow, trans-shipment, decision support and facility location to also identify Operations Research methods to reduce the space consumed by e-waste at present in a more methodical approach.

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On von Neumann's Cellular Automata on Square Grids

Professor Nei Yoshihiro Soma, Mr Jeferson Lesbao Siqueira
Ita - Technical Institute Of Aeronautics

Parallel 9 - Combinatorial Optimisation, The R. Willims Parry (OSCRA), September 12, 2024, 13:30 - 15:00

Biography:

Professor of Operational Research and Theory of Computing at ITA/Brasil. BSc Sao Paulo University; MSc Aerospace Research National Institute; PhD Sheffield University.

Cellular automata are mathematical models developed in 1948 by John von Neumann and Stanislaw Ulam to abstract the logical processes observed in biological systems. They represent a form of computation based on a grid of cells, each with a finite number of states. The state of each cell in the next generation is determined by its current state and that of its neighboring cells, following predefined rules. Stephen Wolfram, inspired by the work of von Neumann and Ulam, has played a significant role in advancing the study of cellular automata. An example is Rule 150, a one-dimensional model where each cell can be in one of two states, either 0 or 1. Sutner's 1989 work partially addressed John von Neumann's inquiry into the inverse of Rule 150. However, von Neumann's interest in understanding how simple rules can lead to complex behavior in dynamic

systems persisted in exploring a concise polynomial characterization for the inverse of his two-dimensional cellular automaton with a local neighborhood rule. This characterization captures the system's behavior over time, considering factors such as the grid size and evolution rule. Despite ongoing efforts, achieving such a characterization for Rule 150 and its two or greater-dimensional counterparts remains a challenging problem in cellular automata research.

We bring here a brief overview of von Neumann's inquiry, which extends beyond a binary answer. We give an explicit solution for detecting inverse configurations when applicable, with computational requirements that are sublinearly bounded for cases 2 and 3. The results have been partially accepted for publication and incorporated into the well-known On-Line Encyclopedia of Integer Sequences (OEIS).

Community OR & Third Sector

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Circularity as a Systems Concept

Kamila Pokorna¹, Dr Miles Weaver², Max Chipulu³

¹Department of Mining Engineering and Safety, Faculty of Mining and Geology, VSB- Technical University of Ostrava, ²The Business School, Edinburgh Napier University, ³The Business School, Edinburgh Napier University

Parallel 1 - Community OR & Third Sector, The Kate Roberts (OSCRB), September 10, 2024, 10:30 - 12:00

Biography:

A PhD candidate with a genuine interest in the intersection of circular economy principles and raw materials. My research focuses on exploring innovative approaches to resource management, waste reduction, and the development of sustainable supply chains. I am driven by a desire to bridge the gap between academia and industry, seeking opportunities to collaborate with stakeholders across various sectors. I am deeply involved in initiatives to raise awareness about the importance of circular economy principles.

A critical management challenge is the move to circular design thinking. Moving away from the “take-make-consume-dispose” linear model of resource consumption (Rasi et al., 2023) to systems that are regenerative and restorative. This is necessary to not overshoot our ecological ceiling (a planetary pressure) to ensure humanity can thrive in a just and safe space (Raworth, 2018). We continue to produce waste that is not disposed of in an environmentally responsible way (Kazancoglu et al., 2021) and to take “virgin” raw materials without regard of many that are finite in nature. A circular economy and supply chains replace this linear thinking with closed-loop systems of material flows by merging a number of various operations, such as maintenance, repair, reuse, refurbishing, remanufacturing, and recycling (Mishra and Hopkinson, 2018). Value is recovered by continual re-use & re-manufacturing of parts/materials as opposed to recycling and energy recovery (Tura et al., 2019). This has two critical implications for systems thinking and communities. (1) We argue that the concept of circularity be grounded in systems ideas, theory, and practice and (2) it is in people and communities’ interest that human activity ought not to deplete resources available as common goods. An initial systematic literature review identified only a small number of contributions that discuss circularity from a systems lens with most contributions in Environment and Earth science and a limited amount in the management literature. Therefore, firstly we ask “What are the principles of circularity and how can systems theory help provide a conceptual basis for further development?” and secondly, with business, governments and communities themselves competing for resources such as clean water, rare earths, oil & gas etc., then “what are the consequences of depleting resources as a common good on often marginalised communities and the future of life on earth?”. This involves several

complexities such as ownership, power structures and culture etc., that need to be reconciled upon reflection of boundaries. Further avenues for research are suggested to advance the concept of circularity as a systems concept and importance of the interdependence and impact of business systems with communities and nature.

4

What is worth fighting for? What makes communities worth developing and maintaining?

Dr Eliseo Vilalta-Perdomo

Aston University. Aston Business School

Parallel 1 - Community OR & Third Sector, The Kate Roberts (OSCRB), September 10, 2024, 10:30 - 12:00

Biography:

My research focuses on how to improve individual and collective performance, in those cases where the alignment of aims and preferences is unattainable, undesirable, nonessential or even unnecessary. I am currently studying the development of sustainable communities of micro-producers, so that they are more resistant to global and / or local logistical challenges. Therefore, I am exploring different human and technological interfaces, within different supply arrangements, that may increase the propensity of individuals to collaborate. In short, my current research is at the intersection of issues such as human performance, technology and sustainable operations. Historical narratives are full of examples illustrating that it is worth joining others in collective endeavours for personal gains; one need only to scan the pages of Homer's Iliad to evidence this claim. The expectations of reaping potential benefits often serve as the impetus for our social cohesion and self-definition as communal beings. Aristotle (2013) claimed that our gift of speech sets us apart from bees or herding cattle, and even though we might agree with this view, it appears somewhat anthropocentric to my taste, given the hierarchical society characteristics observed in bees and the defensive actions performed by cattle against predators. Nevertheless, the discussion regarding our linguistic sophistication and how languages can facilitate the coordination of actions, deserve further exploration.

A fundamental question that emerges from collective actions is the nature of the common good. To answer this is not as simple as it might look. Consider a scenario wherein members of an urban community must determine what to do with a plot of land that might be transformed into a little park, a church, a pool, a cluster of shops, etc. We could ask the members to rank the different possibilities to collectively decide what course of action to follow. This seems sensible, but as Arrow (1950) proved, fairly doing this is impossible. Moreover, Rittel and Weber (1973) made it clear that defining the "common good" is a complex, multifaceted challenge, akin to a wicked problem.

In essence, it is not so clear what personal gains consist of. In Homer's Iliad, characters pursue various objectives, from seeking glory like Hector to longing for plunder like Achilles. Tensions also appear when deliberating on fair mechanisms for determining a collective course of action. Furthermore, other questions such as why individuals seek membership within collectives/communities are not easy to answer either. Therefore, we will evaluate if the use of constructs from the Complex Adaptive Systems tradition - e.g., attractors – are of use to answer this kind of question, and other alternative approaches to answer this type of question too.

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Cultural Heritage Commons – the Adaptation and Survival of Cornish Heritage Organisations within Shared Cultural Landscapes.

Dr Rebecca Herron

University of Lincoln

Parallel 2 - Community OR & Third Sector, Greek Room, September 10, 2024, 13:00 - 14:00

Biography:

Becky Herron is an Associate Professor in Management at the University of Lincoln and has co-directed the Community OR Unit (CORU) since 2001 when she joined the University. During this time she has worked on many community-based research projects - often focussed around the co-creation of community knowledge and understanding social issues more fully in rural communities. She has a particular interest in the organisational sustainability of non-profit organisations and community groups and teaches Research Methods, Philosophy of Research and Community Organisation, Sustainability and Development. Since 2023 she has been an Honorary Research Fellow at the Institute of Cornish Studies (University of Exeter at Penryn) and has a particular interest in Cornish Heritage Organisations.

This paper looks at the ways in which Cornish heritage organisations have self-organised in recent years to withstand changes in their operating environments (social, financial and environmental). It discusses the nature of some of these changes – ranging from 'Black Swan' events such as COVID to other forms of crisis (The Cost of Living Crisis and Climate Crisis for example) as well as more subtle transitions in society (changes in demographics and value systems, social movements and changing cultural interests, changes in funding and political landscapes). These external changes have led to some organisations thriving; but many organisations have had to make considerable changes and some have ceased to operate completely. In all this, individual non-profit organisations, community groups and individuals have often found ways to continue to support the cultural heritage they value – finding new ways to organise themselves and drawing on and creating new resources in the process. However, they are also part of wider collectives (networks of organisations and individuals) supporting in different ways their areas of interest.

This study looks at Cornish heritage organisations, focussing on non-profit organisations that support distinctive features of cultural identity: including industrial heritage (especially tin mining) and ancient/old Cornwall (Neolithic and Celtic heritage and the Cornish Language). Looking at these organisations and the network and interactions between them raises an additional question – what is the nature of the collective Commons they share and maintain? This presentation looks in particular at the concept of ‘Landscapes’ as Commons – from the UNESCO Cornwall and West Devon Mining Landscape World Heritage Site to ancient Neolithic landscapes it also considers wider cultural landscapes including dramatic, artistic and imaginative Commons. It acknowledges the importance of the surrounding seas as a further cultural (and economic) Commons in Cornwall. Using the concept of the Tragedy of the Commons (Hardin, 1968) it explores how volunteers and non-profit organisations have been considering and protecting these Commons and what insights this concept might add to their individual and collective survival, future relevance and vibrancy; including the contribution this might make to strengthening the collective sustainability of these local landscapes.

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The Roof of Africa Charity Project: Using Scenario Simulation in Support of Policy and Strategic Planning for Sustainable Development in Sub-Saharan Africa

Dr Rossen Kazakov¹, Mr Genuine Mwasha², Ms Penka Petrova³, Ms Yavora Kazakova³

¹Heriot Watt University, ²The Roof of Africa, ³Scenario Simlab

Parallel 2 - Community OR & Third Sector, Greek Room, September 10, 2024, 13:00 - 14:00

Biography:

Dr Ross Kazakov, PhD in Management Science

Mr Genuine Mwasha, chair of the Roof of Africa Charity

The Roof of Africa Project is an initiative aimed at promoting sustainable development in Tanzania, focusing on access to education, food, health, and family well-being. Our methodological approach employs system dynamics modelling and scenario simulation to comprehensively plan, implement and analyse the project's contributions to key UN Sustainable Development Goals related to developing access to education, food, health and supporting local families. This project will explore critical factors impacting the initiative's success, including infrastructure development and educational resources, community livelihood uplifting, food and healthcare provision. Through system dynamics lenses, we explore the complex interactions among these factors and their combined effect on elevating the local communities. Preliminary findings suggest that the Roof of Africa Project offers a transformative and replicable model for tackling the multi-dimensional challenges of sustainable development in impoverished communities.

Continuous Optimisation

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Proximal-Stabilized Interior Point Methods: where linear algebra meets convex optimisation

Dr Stefano Cipolla

University Of Southampton

Parallel 1 - Continuous Optimisation, LR5, September 10, 2024, 10:30 - 12:00

Biography:

Stefano Cipolla is a Lecturer in Operational Research at the University of Southampton, where his work focuses on numerical optimization and applications. Before joining the University of Southampton, Dr. Cipolla served as a Postdoctoral Research Associate at the University of Edinburgh and at The University of Padua.

Proximal-Stabilised Interior Point Methods represent a significant advancement in the field of optimization, combining the robustness of proximal techniques with the efficiency of Interior Point Methods. These methods are particularly valuable when solving large-scale/ill-conditioned optimization problems. In this talk we present recent developments and applications, emphasizing their theoretical properties and practical implementations. The presentation is based on:

[1] Cipolla, S., Gondzio, J. (2023). Proximal stabilized interior point methods and low-frequency-update preconditioning techniques. *Journal of Optimization Theory and Applications*.

[2] Cipolla, S., Gondzio, J., Zanetti, F. (2024). A regularized Interior Point Method for sparse optimal transport on graphs. *European Journal of Operational Research*.

[3] Cipolla, S., Gondzio, J. (2024). Proximal-Stabilized Semidefinite Programming. Submitted.

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Distributed Stochastic Mirror Descent

Dr Panos Parpas

Imperial College London

Parallel 1 - Continuous Optimisation, LR5, September 10, 2024, 10:30 - 12:00

Biography:

I am a Reader in Computational Optimization and a member of the the Computational Optimisation Group at the Department of Computing, Imperial College London. Before joining Imperial College I was a postdoctoral fellow at the MIT Energy Initiative (2009-2011). Before that I was a quantitative associate at Credit-Suisse (2007-2009).

The mirror descent algorithm is known to be effective in situations where it is beneficial to adapt the mirror map to the underlying geometry of the optimization model. However, the effect of mirror maps on the geometry of distributed optimization problems has not been previously addressed.

In this paper we study an exact distributed mirror descent algorithm in continuous-time under additive noise. We establish a linear convergence rate of the proposed dynamics for the setting of convex optimization. Our analysis draws motivation from the Augmented Lagrangian and its relation to gradient tracking.

To further explore the benefits of mirror maps in a distributed setting we present a preconditioned variant of our algorithm with an additional mirror map over the Lagrangian dual variables. This allows our method to adapt to both the geometry of the primal variables, as well as to the geometry of the consensus constraint. We also propose a Gauss-Seidel type discretization scheme for the proposed method and establish its linear convergence rate.

For certain classes of problems we identify mirror maps that mitigate the effect of the graph's spectral properties on the convergence rate of the algorithm. Using numerical experiments we demonstrate the efficiency of the methodology on convex models, both with and without constraints. Our findings show that the proposed method outperforms other methods, especially in scenarios where the model's geometry is not captured by the standard Euclidean norm.

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Development of an autoregressive recurrent neural network for the short-term hydropower scheduling problem

M. Sc. Yoan Villeneuve^{1,2}, Ph.D. Sara Séguin^{1,2}, Ph.D. Abdellah Chehri³, M.Sc. Kenjy Demeester⁴
¹Université Du Québec A Chicoutimi (UQAC), ²Group for Research in Decision Analysis (GERAD),
³Rio Tinto, ⁴Royal Military College of Canada

Parallel 1 - Continuous Optimisation, LR5, September 10, 2024, 10:30 - 12:00

Biography:

Yoan Villeneuve is a doctoral candidate in computer science at Université du Québec à Chicoutimi (UQAC). With a Bachelor's and Master's degree in Computer Science already under his belt, Yoan has set his sights on pushing the boundaries of knowledge in the field of mathematical optimization and machine learning. His doctoral research focuses on pioneering applications of machine learning in short-term hydroelectricity production, aiming to address pressing challenges in renewable energy production. Yoan aspires to leverage his expertise to drive positive change in the technology sector, hoping that his research findings inform strategic decisions in the energy industry, leading to more sustainable practices and greater efficiency. Yoan is committed to lifelong learning and professional growth. He seeks opportunities to collaborate with experts in

multidisciplinary fields, fostering innovation and driving progress towards a more sustainable future.

Quebec relies mostly on hydropower for its electricity production, where efficiency is of significant importance. Currently, hydropower production relies heavily on Mixed-integer linear programming (MILP) models, which represent the problem of short-term hydroelectric scheduling (STHS) as a set of parameters, constraints and objectives. These models seek the optimal value of variables representing, among other things, the reservoir water volume and the flow rate to use each hour to maximize energy production. This research proposes to compare the results obtained by a MILP model with those of a neural model based on an autoregressive Long Short-Term Memory (LSTM) model for a system composed of two hydropower plants. The latter is chosen for its ability to recognize short and long-term trends in a sequential data set. Using twelve years of hourly data collected from both Chute-du-Diable and Chute-Savane power plants on the Péribonka River in Saguenay-Lac-Saint-Jean, this project aims to train an LSTM model adopting an autoregressive approach to predict a future interval of water flow for both power stations. This research paves the way for the use of neural modeling techniques to improve the efficiency of short-term hydroelectric production.

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Tensor Methods for Nonconvex Optimization using Cubic-quartic regularization models

Ms Wenqi Zhu, Prof. Coralia Cartis

University of Oxford

Parallel 4 - Continuous Optimisation, Greek Room, September 11, 2024, 09:00 - 10:30

Biography:

I am currently doing a Ph.D. in Applied Mathematics at the University of Oxford supervised by Prof. Coralia Cartis. My interests are continuous optimization, complexity analysis (tensor methods for machine learning), and approximation for large data sets (tensor approximation). I enjoy writing mathematical proofs and designing algorithms that can perform competitively with state-of-the-art approaches. Before joining the Ph.D., I had the opportunity to gain industry experience and worked in the finance industry for 6 years (Goldman Sachs and J.P. Morgan). High-order tensor methods for solving both convex and nonconvex optimization problems have recently generated significant research interest, due in part to the natural way in which higher derivatives can be incorporated into adaptive regularization frameworks, leading to algorithms with optimal global rates of convergence and local rates that are faster than Newton's method. On each iteration, to find the next solution approximation, these methods require the unconstrained local minimization of a (potentially nonconvex) multivariate polynomial of degree higher than two, constructed using third-order (or higher) derivative information, and regularized by an appropriate power of the change in the iterates. Developing efficient techniques for the solution of such

subproblems is currently, an ongoing topic of research, and this talk addresses this question for the case of the third-order tensor subproblem.

In particular, we propose the CQR algorithmic framework, for minimizing a nonconvex Cubic multivariate polynomial with Quartic Regularisation, by sequentially minimizing a sequence of local quadratic models that also incorporate both simple cubic and quartic terms. The role of the cubic term is to crudely approximate local tensor information, while the quartic one provides model regularization and controls progress. We provide necessary and sufficient optimality conditions that fully characterise the global minimizers of these cubic-quartic models. We then turn these conditions into secular equations that can be solved using nonlinear eigenvalue techniques. We show, using our optimality characterisations, that a CQR algorithmic variant has the optimal-order evaluation complexity of $\mathcal{O}(\epsilon^{-3/2})$ when applied to minimizing our quartically-regularised cubic subproblem, which can be further improved in special cases. We propose practical CQR variants that judiciously use local tensor information to construct the local cubic-quartic models. We test these variants numerically and observe them to be competitive with ARC and other subproblem solvers on typical instances and even superior on ill-conditioned subproblems with special structure.

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Quasi-Tensor Methods

Karl Welzel, Dr Yang Liu, Ms Wenqi Zhu, Prof Raphael Hauser, Prof. Coralia Cartis
University of Oxford

Parallel 4 - Continuous Optimisation, Greek Room, September 11, 2024, 09:00 - 10:30

Biography:

Karl Welzel is a PhD student under the supervision of Raphael Hauser in the Numerical Analysis at the University of Oxford. He is interested in higher-order optimization algorithms, their theoretical convergence properties and practical performance.

It is well-known that second-order methods converge much faster than first-order methods. Based on the theory one should expect another speed-up (in terms of function evaluations) when incorporating third-order tensor information. Third-order oracles, however, are almost never available. We therefore propose a generalization of the quasi-Newton approach to higher-order methods. Just like quasi-Newton methods extract second-order information from repeated gradient evaluations, this method extracts third-order information from repeated Hessian evaluations. In each step the new approximation is one that satisfies a higher-order analogue of the secant equation and simultaneously is closest possible to the previous approximation in a weighted Frobenius norm. It can be shown that such approximations recover the true derivative in the limit under certain assumptions and that, in this case, tensor methods using these approximations achieve super-quadratic local convergence. We present small-scale numerical

experiments that show the advantages and disadvantages of using such quasi-tensor methods over second-order models in practice.

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Efficient Adaptive Regularized Tensor Methods

Prof. Coralia Cartis, Prof Raphael Hauser, Dr Yang Liu, Karl Welzel, Ms Wenqi Zhu

University of Oxford

Parallel 4 - Continuous Optimisation, Greek Room, September 11, 2024, 09:00 - 10:30

Biography:

Yang Liu is a postdoc researcher at University of Oxford. His research interests lie in both numerical analysis such as Krylov subspace methods; and high-order nonconvex optimization algorithms, such as quasi-Newton methods, Newton methods and Tensor methods.

High-order methods are increasingly appealing in this era of abundant computational resources. Among them, tensor methods employing p th-order Taylor-based local models within adaptive regularization frameworks (ARp) have recently emerged for both convex and nonconvex optimization problems. Theoretically, they have demonstrated favorable optimal worst-case global convergence rates and p th-order local convergence rates. However, challenges persist in practice. For instance, it has been established that the global minimizer of the subproblem serves as an ideal descent direction when $p = 2$, yet clarity is lacking for higher-order p . Moreover, discontinuities are observed when the adaptive regularization parameter changes in subproblems for any integer $p > 2$. Additionally, the efficiency of updating the adaptive regularization parameter heavily influences numerical performance. In this talk, we will introduce novel updating frameworks featuring a prerejection mechanism to efficiently update the adaptive regularization parameter. Numerical results will be provided to support our claims.

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Need to relax - but perhaps later?

Reflections on modeling sparsity and mixed-binary nonconvex optimization problems

Professor Immanuel Bomze

University Of Vienna

Parallel 5 - Continuous Optimisation KEYNOTE, Drama Rehearsal Room, September 11, 2024, 11:00 - 12:30

In some ML communities, researchers claim that obtaining local solutions of optimality criteria is often sufficient to provide a meaningful and accurate data model in real-world analytics. However, this is simply incorrect and sometimes dangerously misleading, particularly when it comes to highly

structured problems involving non-convexity such as discrete decisions (binary variables). This talk will advocate the necessity of research efforts in the quest for global solutions and strong rigorous bounds for quality guarantees, howcased on one of the nowadays most popular domains - cardinality-constrained models. These models try to achieve fairness, transparency and explainability in AI applications, ranging from Math.Finance/Economics to social and life sciences.

From a computational viewpoint, it may be tempting to replace the zero-norm (number of nonzero variables) with surrogates, for the benefit of tractability. We argue that these relaxations come too early. Instead, we propose to incorporate the true zero-norm into the base model and treat this either by MILP relaxations or else by lifting to tractable conic optimization models. Both in practice and in theory, these have proved to achieve much stronger bounds than the usual LP-based ones, and therefore they may, more reliably and based upon exact arguments, assess the quality of proposals coming from other techniques in a more precise way. With some effort invested in the theory (aka later relaxations), the resulting models are still scalable and would guarantee computational performance closer to reality and/or optimality.

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Novel and Tractable Convex Relaxations of Standard Quadratic Optimization Problems under Sparsity Constraints

Dr E. Alper Yildirim¹, Professor Immanuel Bomze², Bo Peng², Yuzhou Qiu¹

¹The University of Edinburgh, ²University of Vienna

Parallel 5 - Continuous Optimisation KEYNOTE, Drama Rehearsal Room, September 11, 2024, 11:00 - 12:30

Standard quadratic optimization problems (StQPs) provide a versatile modelling tool in a multitude of applications such as mathematical finance, machine learning (clustering) and modelling in biosciences (e.g. selection and ecology). In this talk, we consider StQPs under an additional sparsity or cardinality constraint which, even for convex objectives, renders NP-hard problems. One motivation to study StQPs under such sparsity restrictions is the high-dimensional portfolio selection problem with too many assets to handle, in particular in the presence of transaction costs. We present novel computational approaches to this relevant but difficult problem, involving modern conic optimization techniques, along with significant dimensional reduction, which is essential for tractability of these methods when problem size grows. In addition, we propose a particular generation procedure that systematically avoids too easy instances. We present extensive computational results demonstrating the versatility and strength of the proposed relaxations.

Data Envelopment Analysis

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Congestion, economic and non-economic areas: The production possibility set decomposition

Dr Seyed Rahim Moosavi

Islamic Azad University Shahre Rey

Parallel 8 - Data Envelopment Analysis, LR3, September 12, 2024, 11:00 - 12:30

Biography:

Seyed Rahim Moosavi is currently Assistant and Ph.D. Student at the Department of Applied Mathematics of Islamic Azad University, Shahre Rey Branch, Tehran, Iran, works on Congestion and network DEA topics. His research interests are operations research (OR), data envelopment analysis (DEA), performance measurement, fuzzy linear programming, and stochastic programming. he had two papers for presentation at the 61 annual operational research society conference. Also, he had one paper for presentation on the 2020 IFORS Conference and 6th International Eco-summit 2020. he had two submitted papers in Rairo operations research and two papers in operation research society journal of China

Identifying inefficient decision-making units (DMUs) and diagnosing their inefficiency in their internal structure in the network data envelopment analysis (DEA) represents the connection between these two topics. Regardless of the relationship between the two issues, achieving each DMUs best performance and finding the efficient consumption scale size (CSS) for DMUs is expected. Since the maximum efficiency of each DMU is directly related to the efficiency of the subDMUs (or stages), the decision-maker (DM) requires a balance in the performance of subDMUs to determine the best performance for both stages and DMU. Failure to measure the appropriate, efficient CSS for each DMU may decrease DMU productivity (although efficient). We divided the production possibility set (PPS) into three unique subsets representing the specific consumption size. We then determined DMUs within each section and measured CSS for each DMU according to the area's properties. Also, since congestion is a type of inefficiency, and inefficiency is one of the harmful effects of inappropriate consumption size, congested DMUs could easily be found by identifying a area indicating the congestion CSS. Also, their congestion can be calculated by measuring their distance from the non-economic area frontier. Then we expanded the idea to the two-stage NDEA.

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Resource Efficiency and the Sustainability of Electricity Generation Systems: A Parallel Network DEA Approach with Non-Homogeneity

Dr Charles Turkson¹, Professor Wenbin Liu², Dr Adolf Acquaye³

1University Of Dundee, 2Beijing Normal University-Hong Kong Baptist University United International College, 3Khalifa University of Science and Technology
Parallel 8 - Data Envelopment Analysis, LR3, September 12, 2024, 11:00 - 12:30

Biography:

Charles Turkson is currently a Lecturer in Business Analytics at the University of Dundee School of Business. Charles holds a PhD in Management Science from the University of Kent, and his research interests primarily focuses on Data Envelopment Analysis for efficiency and productivity analysis. Additionally, he is interested in Predictive and Prescriptive Analytics, Environmental Assessments, Sustainability and Sustainable Development, and Operational Research, with applications in Financial Analytics, Energy & Environment, Healthcare, and Supply Chains. This paper examines the sustainability and resource efficiency in electricity production of some European countries. As electricity is generated concurrently from different generation sources, performance assessment of electricity generation should incorporate the differences in the generation portfolios of states. A model is introduced to examine the performance of the electricity generation systems of different European countries while recognising the differences in their generation portfolios. Specifically, a parallel network optimisation model which deals with the non-homogeneity in the production portfolio of units under investigation is proposed. The aim is to allow cross-country benchmarking and overview of the capabilities of different countries in generation using different sources in line with the planned transition unto a single, smart European electricity grid. This study, therefore, provides insights into the overall production performance as well as the generation source-wise performance of each EU country compared to its peers.

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A review of supply chain risk management trends and methods in petroleum supply chains: The position of data envelopment analysis

Dr John Asu¹, Professor Adel Hatami-Marbini, Professor Khalid Hafeez

¹De Montfort University

Parallel 8 - Data Envelopment Analysis, LR3, September 12, 2024, 11:00 - 12:30

Biography:

Dr John Asu is a Lecturer in Business and Management at De Montfort University Leicester. He holds a PhD in business and management and has a background in research on operations management using frontier analysis, including data envelopment analysis (DEA).

Energy is critical for economic, socio-political, and environmental sustainability worldwide. The petroleum supply chain plays a key part in industrialisation but faces uncertainties and complexities. This paper aims to review the growing literature on supply chain risk management (SCRM) in the petroleum industry supply chain from 2010 to 2023, analysing keywords, identifying

potential risk factors, revealing existing mitigation strategies, and discussing various methodological applications.

A particular focus is placed on data envelopment analysis (DEA) as a promising technique for risk management. We explore the advantages and limitations of DEA and discuss its potential integration with other methodologies for more effective risk management. Our findings show that mitigation strategies in the petroleum industry are often influenced by regional, national, or cultural factors, suggesting the need for tailored risk management approaches. Moreover, the existing literature highlights the importance of considering social, cultural, economic, and political factors in assessing industry risks, pointing towards future research directions.

Keywords: Petroleum supply chain, Risk management, Data envelopment analysis (DEA)

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A global Multidirectional Malmquist productivity index for evaluating variable-specific green productivity in the EU

Dr Kwaku Ohene-Asare

De Montfort University

Parallel 9 - Data Envelopment Analysis, LR5, September 12, 2024, 13:30 - 15:00

Biography:

Dr. Kwaku Ohene-Asare is a Lecturer of business analytics, management science, economics, artificial intelligence, data analytics, and cloud computing at De Montfort University (DMU), UK. a associate fellow at Warwick University, UK supervising postgraduate thesis, and a visiting Prof. at University of Johannesburg, South Africa. He earned his Ph.D. in operational research and management science from Warwick University, UK, his MSc. in Economics and Finance (with distinction) from Loughborough University, UK, and his undergraduate degree in Economics (with first-class honors) from The University of Ghana-Legon. Additionally, he is a Decision Science and Machine Learning scholar from MIT, USA and a past DFID (UK) award scholar. His research focuses on, economic efficiency and productivity analysis, data envelopment analysis (DEA), stochastic frontier econometrics, business analytics, management science techniques, data science, AI, machine learning, mathematical programming and their applications. He has published and reviewed papers in Energy Economics, International Journal of Banking, Accounting and Finance, OMEGA, Journal of African Business, The Geneva Papers on Risk and Insurance - Issues and Practice, Journal of International Business, International Journal of Energy Sector Management, European Journal of Operational Research, Journal of Productivity Analysis, Journal of the Operational Research Society, Journal of Cleaner Production, Economics and Business Letters, African Journal of Business Management, and International Journal of Managerial Finance. In UGBS, he developed a research-based course on DEA that integrates research directly into

teaching. Kwaku is also a consultant, life mentor and a learner. His hobbies include soccer, movies, research, public speaking and online teaching.

This paper extends the Asmild, Baležentis, and Hougaard (2016) multi-directional Malmquist productivity change index (MM) to the context of global frontiers. The proposed index is used to evaluate the variable-specific green total factor productivity of 28 countries in the EU. It handles linear programming infeasibility, non-transitivity, and undesirable outputs. It is also decomposed into four components to determine the sources of patterns of environmental productivity change. We show the conditions under which infeasibility may occur under both constant and variable returns to scale and how the proposed global Multi-directional Malmquist index (gMM) addresses these. The index also incorporates non-radial slacks, can generate a single measure of productivity change patterns, and satisfies the axiomatic properties of index numbers (Althin, 2001). A numerical example is presented to illustrate the proposed algorithm. We undertake an empirical application of our approach by assessing patterns of green total factor productivity from 2005 to 2022, explaining the effect of energy use, greenhouse gas emissions (GHG) and regionalisation. The findings suggest that the EU market exhibits variable returns to scale, the MEA is more discriminatory than the DEA, capital (energy) most (least) significantly outperforms the other variables, Western EU is the most efficient whilst Eastern and Central EU are the least. In the EU, 42% (25.2%) of observations are infeasible under the VRS (CRS). Procyclicality in eco-productivity patterns is observed across the EU during the sample period. Yet, no significant differences in productivity levels across dimensions is observed, indicating convergence towards a common EU frontier over time. Some countries are inefficient at a time but show patterns of productivity growth over time. Across all variable dimensions, the most slightly positive driver of dynamic productivity is global scale technological growth, which are on average 0.2%, 0.1%, 0.1%, 0.4% and 0.1% for labour, energy, capital, GHG and GDP productivities respectively. The four-factor decomposition provides extra information regarding the sources of productivity patterns. Regulators therefore need policies to stimulate the scale structures to leverage on the technological spillovers resulting in exploitation of scale economies and expansion in redeployability of the total asset base of nations.

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Robust Data Envelopment Analysis Models: Extensions and Improvements

Dr Aliasghar Arabmaldar¹, Professor Adel Hatami-Marbini²

¹University of Hertfordshire, ²University of Huddersfield

Parallel 9 - Data Envelopment Analysis, LR5, September 12, 2024, 13:30 - 15:00

Biography:

Aliasghar Arabmaldar is currently lecturer in Business Analytics and Systems (BAS) at the Hertfordshire Business School. Before joining BAS, he was postdoctoral researcher at Institute of

Production and Supply Chain Management (PSCM), Technical University of Darmstadt, Darmstadt, Hesse, Germany and also postdoctoral researcher at the Department of Business Administration, Faculty of Business and Economics, Georg-August-Universität Göttingen, Göttingen, Germany. He is an internationally recognized expert in Data Envelopment Analysis, Decision Analysis, Performance Evaluation, Multi-objective programming, and Mathematical Modelling. He has published in top-tier journals including European Journal of Operational Research, Expert Systems with Applications, Operations Research Spectrum, Optimization. He has contributed to numerous international conferences as a presenter. He serves as a reviewer for peer-reviewed journals such as European Journal of Operational Research, OMEGA, Operations Research Spectrum, Health Care Management Science, Socio-Economics Planning Science, Journal of intelligent manufacturing, Computational & Applied Mathematics, Measurement, Financial Innovation, Applied soft computing.

Robust Data Envelopment Analysis (RDEA) adopts a conservative approach to deal with inherent uncertainties, ensuring robust and reliable performance evaluation. RDEA models in the literature utilise robust optimisation techniques within conventional DEA frameworks to seek robust efficiency measures. Notably, RDEA models under budgeted uncertainty have gained attention for achieving a balance between optimality and feasibility in the presence of uncertainty. However, an often overlooked drawback is the potential for excessively conservative efficiency measures, especially with high levels of uncertainty, which could diminish the practical utility of this approach. This paper aims to address this concern by examining existing robust DEA models and introducing two new variants using variable budgeted uncertainty and proportion-based uncertainty, thereby extending and refining the existing robust DEA models.

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Measuring Sustainability Performance of Digital Supply Chains in the era of Industry 4.0

Emmanuel Odumosu

De Montfort University

Parallel 9 - Data Envelopment Analysis, LR5, September 12, 2024, 13:30 - 15:00

Biography:

Emmanuel Oluwaseun Odumosu is a Ph.D. research student in Sustainable Operations Management at Leicester Castle Business School (LCBS), De Montfort University, Leicester, United Kingdom. His research centers on sustainability measurement, operation management, industry 4.0, digital technology, and digital supply chain management, with a specific focus on the digital supply chains in the food and beverage industry in the UK.

Emmanuel holds a master's degree in Accounting and Financial Management from Coventry University and an Advanced Diploma from the London School of Business and Finance. He is

currently an Associate Lecturer at De Montfort University, where he supports and teaches both undergraduate and postgraduate students in operation and supply chain management. His previous role as a Research Assistant involved conducting primary research on digital technology used in supply chains of food and beverage firms within the East Midlands, UK. Before joining academia, he served as the Head of Finance & Business Strategy at Pet-dof International Consult Limited in Lagos, enhancing financial controls and business strategies.

A part-qualified accountant through the ACCA program, Emmanuel has been recognized with an award for Best Transaction Officer during his time in the banking industry where he spent over 6 years. His technical skills include proficiency in various software and accounting applications, which support his analytical and strategic capabilities. He has presented his ongoing research at different conferences, one of them is at the last concluded COP28 in Dubai. His combined expertise in finance, teaching, and research positions him as a leading voice in the fields of finance and supply chain management, where he continues to make significant contributions towards understanding and innovating within these critical areas.

Measuring the sustainability performance of supply chains is fundamental to creating sustainable supply chains and addressing economic, social, and environmental challenges. However, the emergence of the digitalization of supply chains in Industry 4.0 has given rise to larger scopes of data that are available in much greater detail, enhancing computation and analysis capabilities within operational functions. As such there is a need to quantitatively measure the sustainability performance of these digital technologies in the supply chain. The UK's food and beverage sector, notable for its significant contributions to GDP, employment, and environmental impacts, alongside stringent regulatory standards and complex data-rich supply chains, is the chosen focus due to these characteristics.

This research aims to provide a clear structured approach to measure the impact of digital technologies on the three (3) dimensions of sustainability performance (economic, social, and environmental performance). This research utilizes Organizational Information Processing Theory (OIPT) and Dynamic Capability Theory to underpin its framework. OIPT is selected for its robust explanation of how organizations manage and process vast amounts of information, crucial for the complex, data-driven nature of digital supply chains in Industry 4.0. Dynamic Capability Theory is applied to explore how organizations adapt and enhance capabilities through digital technologies, aiming to sustain competitive advantages in dynamic markets. Together, these theories provide a comprehensive approach to studying the strategic integration of digital technologies within supply chains and their effects on sustainability performance.

The research employs a robust methodological framework using input-output analysis and Network Data Envelopment Analysis (NDEA) to quantitatively measure and evaluate the efficiency across the economic, social, and environmental dimensions performance of digital technologies within the UK's food and beverage supply chains. Ultimately, this research will make a significant contribution to digital supply chain management literature by providing a nuanced view of the

sustainability impacts of digital technologies in developed markets, establishing a benchmark for performance measurement, and offering strategic insights for enhancing sustainability practices within digital supply chains. It will use an innovative methodological approach by utilizing an input-output analysis modeling to design a three-stage network DEA framework.

Digital Twins

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On the Validation of Simulation Models for Digital Twin Applications

Prof Stephan Onggo, Professor Christine Currie

University of Southampton

Parallel 7 - Digital Twins, Welsh Seminar Room, September 12, 2024, 09:00 - 10:30

Biography:

Stephan Onggo is a Professor of Business Analytics at the University of Southampton. He is a member of the Centre for Operational Research Management Sciences and Information Systems (CORMSIS). His research interests include simulation modelling methodology and its applications in health care, disaster management and supply chain. His e-mail address is b.s.s.onggo@soton.ac.uk. His website is <https://bsonggo.wordpress.com/>

In recent years, there has been a notable increase in the volume of literature on Digital Twin. An essential aspect of Digital Twin entails creating a digital version of a physical entity, system, or process that stakeholders aim to analyse or oversee. Simulation models are widely used as digital representations in this context. Traditionally, simulation models have primarily served planning functions. However, the advent of Digital Twin technology has shifted this paradigm, requiring simulation for operational management and control purposes. In this presentation, we will explore the necessity for adjustments to existing validation techniques to suit the validation of simulation models within Digital Twin applications. Additionally, we will highlight some recent methods proposed in the literature.

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Digital Twins in healthcare: some reflections on simulation practitioners' needs, desires and challenges in Healthcare 4.0

Mr Tom Stephenson

Simul8 Corporation

Parallel 7 - Digital Twins, Welsh Seminar Room, September 12, 2024, 09:00 - 10:30

Biography:

Tom is the Director of Services and Strategic Partnerships at Simul8. He leads a team who help users to develop simulations worldwide across multiple sectors.

The idea of a digital twin, a virtual replica of a real-world product or system, emerged in the manufacturing sector where it also has had its initial widespread adoption. In the area of simulation modelling, we often hear about smart manufacturing and Industry 4.0. However, in the same vein more and more of our healthcare users are interested in gaining rapid information to help with complex operational decision making by integrating live data into their models. That is,

they want to build a digital twin-embedded simulation to improve on a variety of different challenges, such as patient pathway modelling, assessing bed capacities, or also, improving length-of-stay estimation. In particular, the promises of digital healthcare services, also known as Healthcare 4.0, have led to more awareness of the possible benefits of data to inform decisions on the above, for example through personalised healthcare and intelligent rehabilitation.

In this presentation, I talk about my experiences in the field coming from over a decade of building healthcare simulations and addressing the needs of healthcare professionals when it comes to managing expectations of what a digital twin can deliver. Further, I present several example case-studies and how these were approached, addressing commonly available live data in healthcare while also expanding into related areas such as process mining.

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Machine learning for predictive modelling of simulation inputs: A case study on integrating supervised learning and live data in a discrete event simulation of a natural gas supply chain

Christoph Werner

Simul8 Corporation

Parallel 7 - Digital Twins, Welsh Seminar Room, September 12, 2024, 09:00 - 10:30

Biography:

Christoph Werner is a senior simulation consultant at Simul8. He has been working as part of Simul8's Simulation Excellence team since 2018 where he has delivered numerous simulation projects in various industries, ranging from the automotive, defence, food/beverage and energy industries to healthcare and other service sectors. He has an MSc and PhD in Operational Research and is interested in the research area of simulation modelling and, in particular, common modelling challenges around uncertainty quantification, such as scarce data.

Machine Learning (ML) is becoming an ever more important tool for simulation modellers. Integrating ML in a simulation can assist with input modelling to better implement how complex decisions are being made in a process. Together with regular updates through (near-)live data, ML methods can enhance a simulation model when being used for operational decision-making. The idea is that decision factors and simulation inputs do not directly make use of live data (often such live data is not available). However, they can be reliably predicted via ML, based on certain influencing factors that are available as live data. The advantage is that decisions can be made more reliably depending on specific hourly and daily circumstances. In particular, we use Supervised Learning methods (Neural Networks and Random Forests) to predict several simulation inputs. These Supervised Learning algorithms themselves take in live data in order to produce predictions of key simulation inputs.

In a first example, inspired by a supply chain project in the industrial gas sector, the process flow from producers/suppliers of industrial gases to their corresponding target markets is modelled via a simulation model. With the options to supply these markets by sea and land routes, the main uncertainties in the process are related to travel times of ships and trucks in addition to port handling and truck loading times. While many strategic decisions can be made by the use of a traditional simulation model with historical data, for operational decisions, the current weather, traffic conditions and, for sea transport, wave heights etc. can have a major impact on expected timings. We show how some main factors influencing these timing parameters, which are available as live data, can be used to feed into Supervised Learning methods in order to predict timings in the simulation. Then, the simulation model can be used for prioritizing certain ship routes and scheduling trucks in order to ensure a balanced supply to target markets and avoid time delays.

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AI-powered Cheese Yield Prediction: Applying ML to Develop a "digital twin" for Optimising Yields in Cheese Make

Mr Giwa Reagan Iziomo, Dr Jiabin Luo

Aston University

Parallel 9 - Digital Twins, Welsh Seminar Room, September 12, 2024, 13:30 - 15:00

Biography:

Giwa Reagan Iziomo is a KTP Associate with the Aston University Operations and Information Management (OIM) department. A Data scientist and mechanical engineer with 10+ years of experience driving business success through innovative analytical solutions. He is currently leading a Knowledge Transfer Partnership (KTP) project, a collaboration between Aston University and Butlers Farmhouse Cheeses, funded by Innovate UK. This 2-year project focuses on implementing novel Business Analytics and Machine Learning to drive efficiency, yield, and consistency of processes and products, with the goal of creating AI frameworks for doubling the business size within five years.

Maximising cheese yield while maintaining quality is a significant challenge in cheesemaking due to inherent variability in production factors such as milk composition, irregularities in make process, and changing environmental conditions. This study presents an approach utilising artificial intelligence (AI) and machine learning (ML) to develop a digital twin for simulating cheese yield based on varying cheesemaking features. Historical data on cheesemaking batches from a cheese production company is collected and pre-processed. Exploratory data analysis (EDA) and feature engineering extract valuable insights and capture complex interactions between variables. Various ML algorithms, including regression and decision trees, are explored to predict cheese yield, with the Random Forest Regressor emerging as the most effective model, achieving training and test accuracies of 90.84% and 78.92%, respectively. This winning model is integrated into a user-

friendly digital twin interface, allowing cheesemakers to input cheesemaking variables and receive real-time yield predictions. This solution empowers the cheese experts to simulate production scenarios to virtually test the impact of different parameters on yield before actual production, analyse yield-affecting factors by pinpointing variables significantly influencing yield based on the digital twin's predictions, and optimise process parameters for maximum yield and quality through insights gleaned from the digital twin. Deployment options (cloud-based/on-premises) cater to diverse needs, while continuous model development ensures the digital twin's reliability for improved decision-making and process refinement. Successful implementation of this solution saves annual trials costs while maximising yields. This project offers a practical AI solution for the cheesemaking industry, potentially applicable to the wider food production sector, where complex interactions of variables under tight tolerances determine the final product. It empowers cheesemakers to optimise production and enhance operational efficiency.

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A systems approach to digitalising supply chains towards circular economy and digitalisation

Ms Zulaiha Hamidu, Professor Ben Clegg², Dr Luciano Batista³

¹Aston University, ²Aston University, ³Aston University

Parallel 9 - Digital Twins, Welsh Seminar Room, September 12, 2024, 13:30 - 15:00

Biography:

Zulaiha Hamidu is a first-year PhD student at Aston University from the Operations and Information Management Department, Aston Business School.

Zulaiha has been passionate about research since her final undergraduate level where she was first introduced to research. Ms. Zulaiha has published some works on supply chain management in high-ranked journals.

At the upcoming conference, Zulaiha is excited to present her research on systems thinking for digitalising supply chains towards circular economy and sustainability. She looks forward to meeting and networking with fellow students and professionals to explore and exchange ideas. Introduction: The digitalisation of supply chains stages a promising path for achieving circular economy and sustainability goals. However, accomplishing these goals requires a comprehensive grasp of supply chain dynamics and the integration of systems thinking methodologies.

Research Objective: The research aims to determine the extent to which systems thinking can be effectively applied to digitalize supply chains toward the circular economy and advanced sustainability principles.

Methods: This study explores the application of system dynamics, viable systems models, and PrOH modeling to design resilient and efficient sustainable supply chain systems. Data will be collected using action research.

Expected outcomes: The paper provides a deeper understanding of the supply chain system as a whole rather than concentrating on particular components. Identifying feedback loops in the system consequently leads to insights into supply chain behaviour and potential points for interventions. Additionally, the systems thinking perspective facilitates the identification of opportunities to integrate circular economy competencies and advance sustainability principles into the supply chain. The application of digital technologies in the supply chain system can potentially enhance transparency and traceability across the system. Last but not least, the study is expected to contribute to achieving some sustainable development goals like climate action, responsible consumption and collaboration/partnership for the goals.

Keywords: System thinking, Circular Economy, Digitalisation, System Dynamics, Viable Systems Model, PrOH Modelling, Sustainable supply chains

Education in OR & Analytics

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Why do students choose (or avoid) AI technologies in their education?

Dr Aniekan Essien¹, Dr. Marios Kremantzis¹, Dr Oyegoke Bukoye², Dr Christine O'Dea³

¹University Of Bristol, ²University of Bath, ³King's College London

Parallel 6 - Education in OR & Analytics, Welsh Seminar Room, September 11, 2024, 13:30 - 15:00

Biography:

Dr Aniekan Essien is a Lecturer (Assistant Professor) in Business Analytics and the Director of BSc Business Analytics Program 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.

In this study, we explore the influence of external signals on student intentions to use AI technologies in higher education, considering how societal trends, institutional messages, and peer feedback shape their perspectives and decisions. Adopting a mixed-methods approach to students across universities across the world, we gather insights from over 300 students to understand the varying factors driving or deterring AI adoption. Our findings indicate a significant impact of external signals, with institutional support playing a crucial role in shaping student attitudes towards AI. However, a gap exists between student curiosity and actual engagement, influenced by factors such as awareness, misconceptions, and ethical concerns. This research highlights the importance of comprehensive AI literacy within educational frameworks, emphasising the need for targeted communication strategies to address misconceptions and ethical considerations. By offering a deeper understanding of the dynamics at play, our study contributes to the development of more effective educational policies and AI integration strategies, aiming to foster an informed, ethical, and inclusive AI-enabled educational environment.

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Evaluating the impact of AI chatbots on student engagement and support in higher education (HE)

Dr. Marios Kremantzis¹, Dr. Anthi Chondrogianni¹, Dr Aniekan Essien¹

¹University of Bristol

Parallel 6 - Education in OR & Analytics, Welsh Seminar Room, September 11, 2024, 13:30 - 15:00

Biography:

Marios Kremantzis serves as a Lecturer (Assistant Professor) in Business Analytics and holds the role of Programme Director for MSc Business Analytics at the University of Bristol.

Marios is a decision scientist whose research focuses on optimisation, DEA, efficiency measurement, and multi-criteria decision analysis. His extensive experience involves constructing and applying mathematical models to extract insights from data and devise practical solutions. Proficient in assessing systems with various network structures using the DEA technique, he has published his work in esteemed journals including *Studies in Higher Education*, *Expert Systems with Applications*, *Socio-Economic Planning Sciences*, *Operational Research*, *RAIRO-Operations Research*, *Agriculture*, *Supply Chain Analytics*, and *IJFSD*. Marios has also organized special sessions for esteemed conferences such as those by the UK's Operational Research Society, IFORS, DEA45, and the Athens Institute for Education and Research.

Moreover, Marios is the Founder and Chair of the "OR, Analytics & Education" SIG within the OR Society. He is a Fellow of the Higher Education Academy (FHEA) and has been appointed as a National Representative on the General Council of the UK's OR Society! He is honored to take on a pivotal role in the Education sub-committee of this Board. Renowned for innovative teaching methods and authentic assessment practices, including the use of a Chatbot and Team-Based Learning, he was honored with the "Inspiring and Innovative Teaching Award" at the 2023 Bristol Teaching Awards and received nominations for the same award in 2022, along with the "Outstanding Personal Tutoring Award." Additionally, Marios acts as the Guest Editor for two Special Issues on enhancing student engagement through Artificial Intelligence and text generators (ChatGPT) in "Studies in Higher Education" (ABS3*) and the "Journal of University Teaching and Learning Practice".

Our study investigates the role of AI Chatbots in fostering student engagement and accessibility to course-related support in higher education. Addressing a crucial gap in the understanding of technology-driven solutions for student services, it offers a nuanced perspective on the potential of AI-powered support mechanisms. By evaluating the performance of Chatbots across two distinct cohorts in both the School of Economics and the Business School, the research delivers multifaceted insights beyond previous single-instance studies. In achieving this, we set out to answer the key research question: "How effective are AI Chatbots in supporting students in higher education analytics courses?". The primary objectives of this research were to evaluate the effectiveness of AI Chatbots in providing course-related information and support to students in HE and shed light on their perceptions of these interactions, contributing to a holistic understanding of their integration within the learning environment. This research is particularly timely, considering the growing centrality of digital solutions in educational strategies and the transformative potential of AI Chatbots in reshaping traditional support models.

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Navigating Challenges and Complexities: Re-imagining the Identity of MSc Business Analytics Programmes amid AI - A Viability Approach

Dr Salimeh Pour Mohammad

University of Warwick Business School

Parallel 8 - Education in OR & Analytics, Greek Room, September 12, 2024, 11:00 - 12:30

Biography:

Dr. Salimeh Pour Mohammad is an Associate Professor of Business Analytics. She is a Curriculum Designer for business analytics and management courses. She joined The University of Warwick Business School in August 2023 and serves the wider academia as a:

- * Reviewer/Assessor of the National Teaching Fellow Scheme (NTFS) of Advance HE (Higher Education Academy)
- * Assessor of Warwick Teaching Excellence Awards (WATE Judge) at the University of Warwick
- * Aurora Mentor for Leadership Development Initiative of Advance HE (Higher Education Academy)
- * Co-organiser of Warwick Education Conference (WEC)

Salimeh is a Senior Fellow of Advance HE. Her teaching style is based on a systemic teaching-learning-assessment approach. She applies some of the second-order cybernetics principles to facilitate viable and effective programme leadership.

Before joining WBS, she was a Senior Lecturer and Programme Director of MSc Business Analytics at the University of Exeter Business School and a member of the University-Wide Data Science Education Committee as well as the Accreditations and Ranking group at Exeter University. Before that, Salimeh has also worked as a lecturer for UG and PG programs at the University of West London Business School where she led management courses in four international campuses (UAE, China, Cyprus and London) from the London campus. Salimeh has worked as a lecturer and as a lead tutor at The University of Hull. Her academic passion and practice have been recognized through the "Outstanding Performance Award" at Exeter Business School, "The Star Award" at the University of West London Business School, and the "Best Tutor Award" at the University of Hull Business School.

Research Interests:

Salimeh is a reviewer of the British Journal of Management and Academy of Management.

- * Business Analytics,
- * Network Analytics,
- * Second-order Cybernetics

Although MSc Business Analytics Programmes are considered the "Golden Goose" of Business Schools, however, there is a very limited account of research exploring the intricacies and

complexities concerning the development, leadership, and delivery of such programmes. In addition, research is scarce in examining MSc Business Analytics Programmes from the viability perspective and how such viability can be sustained, despite dynamic changes in industry demands, analytical technologies, and the seemingly omnipresence of artificial intelligence (AI). This paper examines the challenges of leading and managing an MSc Business Analytics programme in a UK business school. The author uses the viable system perspective (VSM) and studies the “Identity” of an MSc Business Analytics Programme, its Structure, and Dynamic Processes/Mechanisms, as well as the Intertwined roles and responsibilities of key Programme Stakeholders in the co-evolution of the programme’s success journey in a viable manner. Reflecting on the distinctiveness of the viability approach, the author advocates for carefully re-imagining the identity of MSc Business Analytics Programmes - an intentional alignment with the imperatives of viability in navigating the complexities and dynamic shifts while safeguarding Business Analytics Programmes' long-term viability.

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Leveraging GenAI for Innovative Operations Management/Research Module Design: A Comparative Analysis

Dr Eliseo Vilalta-Perdomo¹, Dr David Salinas-Navarro¹, Dr Rosario Michel-Villarreal²
¹Aston University. Aston Business School, ²University of Leeds. School of Earth and Environment.
Sustainability Research Institute
Parallel 8 - Education in OR & Analytics, Greek Room, September 12, 2024, 11:00 - 12:30

Biography:

My research focuses on how to improve individual and collective performance, in those cases where the alignment of aims and preferences is unattainable, undesirable, nonessential or even unnecessary. I am currently studying the development of sustainable communities of micro-producers, so that they are more resistant to global and / or local logistical challenges. Therefore, I am exploring different human and technological interfaces, within different supply arrangements, that may increase the propensity of individuals to collaborate. In short, my current research is at the intersection of issues such as human performance, technology and sustainable operations. This work outlines a pioneering approach in the development of an Operations Management/Research (OM/OR) module by integrating principles of experiential learning and authentic assessment and using a Generative Artificial Intelligence (GenAI) tool, specifically ChatGPT3.5. GenAI has been defined as a “technology that (i) leverages deep learning models to (ii) generate human-like content (e.g., images, words) in response to (iii) complex and varied prompts (e.g., languages, instructions, questions)” (Lim et al., 2023, 2). The emergence of Generative Artificial Intelligence (GenAI) tools, exemplified by ChatGPT3.5, introduces a paradigm shift in academia. While concerns about plagiarism and impact on student learning persist, this

paper focuses on an underexplored dimension – the potential support that GenAI tools can provide to academics in designing effective Operations Management/Research (OM/OR) modules. The selection of ChatGPT3.5 is justified by its free accessibility and demonstrated potential to support academics in teaching and learning activities. The work aims to showcase the value of GenAI tools in designing engaging educational experiences while acknowledging the need for human expertise in refining and validating the generated proposals.

To delve into the capabilities of GenAI tools in supporting OM/OR educators, we adopt a 'thing ethnography' approach, treating GenAI as a subject with its own non-human worldview. A semi-structured interview with ChatGPT3.5 is conducted to identify what undergraduate students should learn from an OM/OR module and how to translate that knowledge into learning outcomes. A set of twelve questions is designed for this purpose.

Finally, the validation of the ChatGPT3.5 proposals will be done through a comparison with an OM/OR module previously designed traditionally.

This work concludes that GenAI tools emerge as a cost-effective and accessible means for initiating the structure of an OM/OR module. While these tools offer valuable insights and ideas, human involvement remains crucial to validate and enhance the learning experience. Successful OM/OR modules require the expertise of academics to enrich scenarios with complex data and challenging decision-making, ensuring a comprehensive and impactful learning journey for students.

Forecasting

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Data Decisions: Getting Most Bang for your Buck

Dr Robert Leese

Smith Institute

Parallel 2 - Forecasting, LR3, September 12, 2024, 13:00 - 14:00

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A Forecasting Based Approach to Determine How to Treat a Product in a Hybrid Production Environment.

Dr Chris Davies

Bangor University

Parallel 8 - Forecasting, Welsh Seminar Room, September 12, 2024, 11:00 - 12:30

Biography:

Chris is a lecturer at Bangor University, his interests lie in forecasting, analytics, supply chains, Industry 4.0, cybernetics. He gained his PhD in 2019 and has been working at Sheffield Hallam University and Bangor University since graduation.

Inspired by a company requiring a simple decision framework to determine which products get Made to Stock (MTS), and which products get Made to Order (MTO) we propose a dynamic selection process that utilises forecasting to inform that decision. The process is dynamic in that the decision is carried out at regular intervals to reflect the changing characteristics of the products demand. This will mean that over time a product will shift from being MTO or MTS depending on the changing demand history of that product. Although there is a body of work on decision frameworks, little focuses on the changing history effecting that decision. In addition, to the best of our knowledge none uses forecasting as a variable in that decision. We use the MASE error metric, as a measure of 'forecastability', and the average overall demand across the products as decision variables. We compare the output of this framework with another simple decision process based on work by Soman et al (2007).

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Price Forecasting in the European Power Market

Prof Raphael Hauser

Oxford Mathematical Institute

Parallel 8 - Forecasting, Welsh Seminar Room, September 12, 2024, 11:00 - 12:30

Biography:

Dipl. Math. ETH (Swiss Federal Institute of Technology, Zurich, Switzerland). PhD in Operations Research (Cornell University, Ithaca, USA). Associate Professor in Mathematical Programming (Mathematical Institute, University of Oxford, UK) and Tanaka Fellow in Applied Mathematics (Pembroke College Oxford, UK)

The topic of this talk concerns futures and day ahead markets in Central Western Europe, where zonal pricing is used to guarantee that all customers across certain geographic regions pay the same price. We forecast prices via simplified market models with parameters such as network constraints and physical characteristics of power plants calibrated from historical prices. Out-of sample testing shows good alignment between forecasts and observed market prices. The talk is based on joint work with Miha Troha, Julien Vaes and Ioan Alexandru Puiu.

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Cyclical Fluctuation and Technological Innovation in Industry Dynamics

Professor Diana Tsai

National Yang Ming Chiao Tung University

Parallel 8 - Forecasting, Welsh Seminar Room, September 12, 2024, 11:00 - 12:30

Biography:

Diana HweiAn Tsai is a strategy, entrepreneurship, and growth professor at the Institute of Business and Management, National Yang Ming Chiao Tung University. She was Commissioner of the 7th and 8th sessions of the Taiwan Fair Trade Commission, Professor, and Director at the Institute of Economics of NSYSU, research associate at the Institute for Policy Analysis, University of Toronto, and assistant professor of Concordia University, visiting scholar at Stanford University, visiting research fellow at the University of California at Santa Cruz. She also serves as a consultant for the Economics and Technology group of the National Policy Foundation, Chair of the Industrial Policy group of the Taiwan Competitiveness Forum, and an editorial board member of Fair Trade Quarterly.

Her research focuses on strategy, entrepreneurship and growth, startup and operation in BioICT, and industrial organization and regulation. Current research includes M&A and competitive strategy, economic analysis of the competition policy, empirical studies in digital convergence, and economic analysis of intellectual property rights. She has papers published in Journal of Productivity Analysis, Contemporary Economic Policy, Journal of Policy Modeling, Information Economics and Policy, Taiwan Economic Review, Taiwan Academic Journal, Management Review, City and Planning, Issues and Studies; and is author of Empirical Foundation of Incentive Regulation in Telecommunications, published by Management Study Research Center, National Sun Yat-Sen University, and Macroeconomic Environment as Implicit Industrial Policy: Its Industry and Enterprise Effects coauthored with Dr. J.R. Norsworthy published by Kluwer Academic

Publishers. She was award receiver of National Science Council research awards, the Mackay Research Award of 1994 and 1998, the Australian Government competitive grant in 2008, Fulbright Scholar in 2009, the 14th, 16th, 18th, and 20th National Innovation Award (2017, 2019, 2021, 2023), Gold Medal of the 8th International Innovation and Invention Competition (2017), and Fellow of The Higher Education Academy (2019).

The emerging technological innovations in AI, 5G, and information technologies have propagated new market opportunities for the semiconductor industries, and the AI augmenting design and manufacturing of semiconductors have then been applied and spilled over to other related high technology industries. The COVID-19 epidemic has caused a huge increase in the demand for chips: the automobile, mobile phones, and electronic products are all rushing for chips. When the demand exceeds supply, the competition for chips has expanded to grab chips due to the shortage of chip supply, ignoring any possible interplay between supply and demand and overlooking the resulting cyclical fluctuation that may be caused by demand uncertainty. In markets with cyclical fluctuations and demand uncertainty, firms may have different dynamic decision rules facing upturns and downturns of industry cycles. We formulate a new dynamic framework for cyclical fluctuation and demand uncertainty and integrate regime-switching industry cycles. Drawing on firm-level data of Taiwan's high-technology industries, we trace how Taiwan's high-technology companies upgraded their dynamic capabilities in facing asymmetric cyclical behavior and endogenous demand uncertainty. Explicitly incorporating the Markov regime-switching mechanism, we measure the firm's dynamic adjustments when facing upturns and downturns of industry cycles. We also evaluate the firms' dynamic decision rule and the resulting procyclical or counter-cyclical behavior in industry cycles. By unpacking the complex structure of industry cycles, the study extends the existing understanding of how some high-technology industries are more cyclical than others and attributes to capacity expansionary competition as a strategic competition. We conclude by highlighting the implications for research on the adjustment speed of essential inputs and the challenge of optimal forecasting of the expansionary and contractionary phases of the industry cycles.

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Reliability of deep learning methods for residual forecasting: A case study of agricultural food commodity prices in Uganda

Mr. Mutungi Gilbert

Makerere University

Parallel 9 - Forecasting, The Kate Roberts (OSCRB), September 12, 2024, 13:30 - 15:00

Biography:

Gilbert Mutungi is a PhD student and Assistant Lecturer at Makerere University. Gilbert's research interests are in forecasting of long memory processes and use of deep learning methods to enhance statistical forecasting.

He has a Master of Statistics from Makerere University where he also obtained a first class degree in Statistics.

Hybrid forecasting methods that combine classical statistical models with deep learning techniques have gained popularity in the forecasting arena. These approaches have shown promise in capturing complex non-linear relationships and reducing forecasting errors. Despite this progress, very limited study has been conducted on the reliability of deep learning methods in forecasting residuals from statistical models.

This study aims at investigating the reliability of deep learning methods, specifically Long Short-Term Memory (LSTM) networks and artificial neural networks, in forecasting residuals obtained from Auto Regressive Integrated Moving Average (ARIMA) models.

The study will rely on data on monthly commodity prices obtained from the Food and Agricultural Organization Statistics (FAOSTAT) and rainfall volume data from the Uganda National Meteorological Authority ranging from 2013 to 2023. The ARIMA model will be employed to forecast the prices of beans and maize. Subsequently, residuals from the ARIMA model along with rainfall volumes will be used as inputs for LSTM networks and artificial neural networks. Continuous Rank Probability Score (CRPS) will then be used to evaluate the model's ability to predict the distribution of residuals.

Results from this study will provide insights into the reliability of deep learning methods for modelling forecasting residuals thus contributing to the understanding of combining statistical and deep learning approaches for more accurate price forecasting.

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Forecasting Prices of agricultural food commodities in Uganda: A long memory approach

Mr. Mutungi Gilbert

Makerere University

Parallel 9 - Forecasting, The Kate Roberts (OSCRB), September 12, 2024, 13:30 - 15:00

Biography:

Gilbert Mutungi is a PhD student and Assistant lecturer at Makerere University. His research interests are forecasting long memory time series and use of Artificial intelligence to enhance statistical forecasting.

Gilbert has a Master of Statistics degree from Makerere university where he also obtained a first class honors degree in Statistics.

Accurate price forecasts are crucial for effective risk management in the agricultural sector of developing countries. This study utilized data from the Food and Agricultural Organization to investigate the presence of long memory and persistence in the prices of beans and maize in Uganda. Additionally, the study compared the forecasting performance of classical short memory models, namely ARIMA, ETS, and Seasonal Naïve, with that of the long memory Fractionally Integrated Moving Average (ARFIMA) model for beans and maize price forecasting in Uganda.

The findings revealed strong persistent behavior in the prices of both commodities, suggesting a strong likelihood of continuous price increases over time. Moreover, the evaluation based on Root Mean Square Error and Mean Absolute Percentage Error metrics demonstrated that the long memory Fractionally Integrated Moving Average models outperformed the short memory models in forecasting beans and maize prices in Uganda. Specifically, the RMSE values indicated a reduction in forecasting error of approximately 16.3% for the beans price series and 40.2% for the maize price series when employing the long memory model.

In light of these findings, it is recommended that the Uganda Bureau of Statistics adopts the utilization of long memory models for agricultural commodity price forecasting. Additionally, the government of Uganda is advised to implement measures to monitor and inform citizens about the anticipated increase in food commodity prices. For future research, it is suggested to explore the performance of machine learning models that are proficient in handling long-range dependence for forecasting food commodity prices in the country

Global Challenges

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An Assessment of the Sustainability of Electricity Consumption among European Countries. A Multistage Network Data Envelopment Analysis

Dr Charles Turkson¹, Professor Wenbin Liu², Dr Adolf Acquaye³

¹University Of Dundee, ²Beijing Normal University-Hong Kong Baptist University United International College, ³Khalifa University of Science and Technology

Parallel 9 - Global Challenges, Greek Room, September 12, 2024, 13:30 - 15:00

Biography:

Charles Turkson is currently a Lecturer in Business Analytics at the University of Dundee School of Business. Prior to this position, he served as a Lecturer at the University of Kent and has also held previous roles at the University of Cape Coast, the University of Ghana, and the Hong Kong Baptist University. Charles holds a PhD in Management Science from the University of Kent, and his research interests primarily focus on Data Envelopment Analysis for efficiency and productivity analysis. Additionally, he is interested in Predictive and Prescriptive Analytics, Environmental Assessments, Sustainability and Sustainable Development, and Operational Research, with applications in Financial Analytics, Energy & Environment, Healthcare, and Supply Chains. The demand side of the energy system has been a prominent focus in energy and environmental policy. For years, OR applications in the Data Envelopment Analysis literature have been used to provide decision support for policy. However, previous assessments have mostly focused on examining sustainability dimensions separately. In this paper, we propose an extension to the current eco-efficiency, social development assessment, and environmental performance literature. Our approach involves a concurrent assessment that reveals the interrelationships and complementarities between these assessments in the policy. This way, we can demonstrate that decisions made regarding economic development have implications for social development, environmental performance, and electricity generation. We also propose novel approaches for social and environmental performance assessments to examine the impact of electricity consumption on human development and environmental systems. Our assessment provides a framework for examining how energy can be used for both economic and social purposes while minimizing its impact on the environment

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Empirical Research on ESG Factor-Optimized Asset Pricing and Multifactor Models

Mrs Sinian Zheng¹, Mrs Alessia Paccagnini¹, Mr Valerio Poti¹

¹UCD Michael Smurfit Business School

Parallel 9 - Global Challenges, Greek Room, September 12, 2024, 13:30 - 15:00

Biography:

Research interests: Financial markets, Forecasting, Econometrics, Chinese Stock market, Asset pricing, Machine learning, Big data

Sinian is a full-time PhD student at UCD Smurfit Business School. She has a bachelor degree of commerce (first class honor) from UCD and a BSc in Economics from Beijing University of Technology in China, and a MSc in Finance from UCD smurfit.

This paper takes the ESG ratings of A-share listed companies as the research object, explores the effectiveness of ESG non-financial factors and its three sub-factors (E, S, G) in the Chinese Mainland stock market, and examines whether ESG can provide additional information for asset pricing. Empirical results show that adding ESG factors to the Fama-French three-factor model enhances its explanatory power for asset returns, especially for assets with ESG characteristics, where the four-factor model demonstrates stronger explanatory ability.

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Modelling Displacement, Speed and Acceleration of Sustainability Transitions in Transnational Companies and Global Supply Chains

Dr. Vitor Souza, Prof. Fredrik Nilsson

Parallel 9 - Global Challenges, Greek Room, September 12, 2024, 13:30 - 15:00

Biography:

itor Miranda de Souza is a postdoc at the Packaging Logistics division of the Design Sciences department. He is currently working on a three-year project which aim is to accelerate the sustainable transition of Global Value Chains towards the Circular Economy. He is a Doctor of Engineering with a track record of articles and teaching courses in the fields of Sustainable Operations Management and Mechanical Engineering. Former MCSA fellow and experienced in Product Development process of Automotive industry components.

In an era marked by increasing awareness of environmental and social challenges, the imperative for Transnational Companies (TNCs) to accelerate sustainability transitions has never been more pressing. TNCs play a central role in this transition since their previous hunt for cost reductions incurred in transferring their environmentally damaging production processes to countries with less-demanding regulations. Recently, new legislation and consumer awareness have pushed to increase the speed of TNCs and their suppliers' transitions – i.e., the transition of the Global Supply Chain (GSC) as a whole - towards more sustainable processes and activities. In this context, properties like speed and acceleration remain to be defined; we address this gap by proposing a model to measure the displacement, speed and acceleration of TNCs and their GSCs towards sustainability.

The GSC is approached as a Socio-Technical System (STS), and sustainability transitions, as “processes of long-term structural changes of (i) ways of doing, thinking, organising, and of (ii) institutions, and values” (Loorbach et al., 2017). We breakdown displacement in five evolutionary stages: conventional, green performance, sustainable, restorative, and regenerative (Mang and Reed, 2012). Speed is defined in multiple dimensions - like the amount of Greenhouse Gases (GHG) emitted per year and the amount of virgin resources used - and combined in a velocity vector. Using empirical data, we determine, for TNCs and GSCs, the current evolutionary stage, speed, and acceleration, discussing it in terms of the company’s strategy - e.g. adopting Circular Economy strategies like reduce, reuse and repair, or implementing Industry 5.0 principles -, and the nature of the GSCs, for example, concerning product complexity.

Finally, our model provides a systematic way for measuring and benchmarking the progress of TNCs and GVCs over time, that can be used to inform strategic decision-making. As such, our research contributes to the growing body of literature on Sustainability Transitions of GSCs, catalyzing the transition to a more sustainable future.

Health & Social Care

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The NAO's assessment of NHS England's modelling for the Long Term Workforce Plan

Mrs Ruth Kelly¹, Mr Shivam Sood¹, Dr Hannah Kreczak¹, Dr Laura Cole¹

¹National Audit Office

Parallel 1 - Health & Social Care, LR2, September 10, 2024, 10:30 - 12:00

Biography:

Ruth Kelly is Chief Analyst at the National Audit Office (NAO) and has wide experience of applying economics and other analytical approaches to support value for money and policy evaluation, investment decisions and risk management. She directed the NAO's reports on NHS England's modelling for the Long Term Workforce Plan and on financial modelling in government. Prior to joining the NAO, she held business evaluation and risk management roles for a global resources company, and advised clients on carbon and energy issues for a Big 4 economic consultancy practice.

Hannah Kreczak is a Senior Analyst at the NAO and co-leads the Data Analytics and Modelling disciplines supporting Value for Money audits. She chairs the North-East regional branch of the OR Society network and prior to the NAO, she was a post-doctoral researcher in the fields of fluid dynamics and dynamical systems.

Modelling is at the heart of how the government understands its planning and spending decisions that often have major impacts on people's lives. In June 2023, NHS England (NHSE) published its Long Term Workforce Plan (LTWP). Based on an extensive modelling exercise, the LTWP estimated a current shortfall between workforce supply and demand of approximately 150,000 full-time equivalent (FTE) NHS workers, and projected a shortfall of between 260,000 and 360,000 staff by 2036-37. The model also allowed for the testing of high impact policy levers and initiatives, as a means to identify ways to meet the NHS's workforce needs over the next 15 years. NHSE has committed to continue to develop its modelling and the LTWP, publishing a refreshed projection every two years, or aligned with fiscal events as appropriate. This talk will share insights into the National Audit Office's approach to model audit, and how the findings and recommendations from our assessment of NHSE's modelling will provide ministers and officials with a better basis for reaching workforce planning decisions in future.

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Improving acute hospital flow through real-time stochastic modelling of daily discharge requirements for continuing care

Dr Richard Wood^{1,2}, Dr Nick Howlett¹

¹UK National Health Service, ²University of Bath

Parallel 1 - Health & Social Care, LR2, September 10, 2024, 10:30 - 12:00

Biography:

Richard Wood is Head of Modelling and Analytics at NHS Bristol North Somerset and South Gloucestershire Integrated Care Board, and a Visiting Senior Research Fellow at University of Bath School of Management.

Failure to promptly discharge acute hospital patients can lead to elevated bed occupancy which can compromise patient safety and have knock-on effects for upstream services like Accident and Emergency. A barrier to timely acute discharge is often the availability of intermediate care services for patients that require continuing rehabilitative care past the point of being medically fit. In the NHS, these time-limited services are known as 'Discharge to Assess' (or D2A) and there are three pathways along which such patients can be routed following acute discharge readiness – Pathway 1 involves daily home visits and Pathways 2 and 3 involve bedded care (with the latter reserved for those with particularly complex needs). If there is insufficient capacity along the D2A pathways, then the patients wait (i.e., queue) within the acute hospitals. We develop a real-time computer simulation model to stochastically estimate, for each of the next ten days, (1) the number of acute patients that will become ready for discharge along each of the D2A pathways, and (2) the total number of acute patients that will be awaiting discharge (i.e., the queue size). These are based on personalised predictions of discharge readiness date and D2A pathway requirement for all currently admitted patients not yet in a D2A queue. These outputs are combined with the corresponding (non-personalised) predictions for new acute admissions, which are forecasted through a time-series method. The models, updated each day with the latest data, have been implemented in a large healthcare system in and around Bristol, with outputs used to support efforts to improve hospital flow through enhanced discharge planning.

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Strategic Workforce Modelling and Analysis at NHS Wales

Dr Siôn Cave, Ryan Cunningham

Decision Analysis Services Ltd

Parallel 1 - Health & Social Care, LR2, September 10, 2024, 10:30 - 12:00

Biography: _

Health Education and Improvement Wales (HEIW) is the strategic workforce body for NHS Wales. As a Special Health Authority, HEIW makes a unique contribution to addressing strategic and specialist workforce issues, making Wales a great place to train and work for health and care staff and maximising the contribution of all professions and occupations through statutory functions. As part of HEIW's Workforce Strategy, Planning, and Intelligence function the HEIW Analytics team produces a range of workforce information and workforce modelling at a national and sub national level for NHS Wales. Workforce demand and supply modelling helps to support planning decisions that contribute to meeting patient needs and helps to investigate if current recruitment and retention will be sufficient to enable future demand to be met. This presentation will describe the generic workforce demand and supply simulation model used by HEIW to support the strategic workforce planning. The system dynamics based model has been developed using Python, Vensim, Power BI and Excel.

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Generalized or Specialized Hospitals: An Analytical Queuing Approach to Explore Clinical Service Configurations

Navid Izady, Dimitris Paraskevopoulos, Mr. Mohammad Aminjarahi

Parallel 2 - Health & Social Care, LR2, September 10, 2024, 13:00 - 14:00

In multi-hospital networks (MHNs), a critical decision revolves around how to allocate clinical services across different hospitals with limited capacity. This decision typically falls between two extremes: a fully generalized configuration where all services are offered in every hospital, and a fully specialized configuration where each hospital exclusively provides one service. However, research and practical evidence indicate that neither fully specialized nor fully generalized configurations are optimal. In our paper, we present a mathematical model along with an exact analytical solution to explore the optimal service configuration within an MHN comprising two hospitals of equal fixed capacity and two services. Our model addresses uncertainty by incorporating queueing theory and economies of scale, crucial factors in service configuration problems. Through extensive numerical experiments, we demonstrate that, in most scenarios, a semi-specialized configuration emerges as optimal, maintaining one hospital as general and the other as specialized. Nonetheless, there are specific circumstances where alternative configurations, such as fully specialized or fully generalized, may prove optimal.

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Appointment scheduling for a nuclear medicine department

Dr Mei Tuson, Professor Rym M'Hallah

Parallel 2 - Health & Social Care, LR2, September 10, 2024, 13:00 - 14:00

Biography:

Dr. Mei Tuson is a PhD student at KCL Engineering.

This research optimizes the appointment scheduling within a nuclear medicine department where the objective is to mitigate the impact of the supply chain uncertainty. We model the problem as a stochastic mathematical program and employ a discrete event simulation to assess the impact of uncertainty of supply and of delivery times on retrospective appointments data. The experimental results highlight the impact of uncertainty on the performance of the department. It further illustrates how optimized scheduling may reduce the cost of pharmaceuticals while increasing patients' throughput.

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The growing intersect of health research, trial methodologies and data science

Dr Zoe Hoare

Parallel 3 - Health & Social Care, LR2, September 10, 2024, 14:10 - 15:10

Biography:

Zoe Hoare is currently Director and Principal Statistician at North Wales Organisation for Randomised Trials in Health (& Social Care) (NORTH) - a UKCRC accredited clinical trials unit based at Bangor University. NORTH currently has a portfolio of active studies that has a total grant value of approximately £28 million with a network of collaborators from across the UK. Zoe has contributed to a wide portfolio of clinical research studies particularly focusing on the pragmatic evaluation of complex interventions in a variety of health areas. Mental health and dementia trials are of particular interest. Methodologically Zoe is interested in the consideration of composite outcomes within the context of complex interventions, the impact of stop/go criteria on the development of trials and the visualisation of evaluation results to aid interpretation. Zoe is a member of the editorial board for both British Dental Journal and the journal of Aging and Mental Health, as well as being a Senior Editor for the Pilot and feasibility studies journal. She also acts a funding panel member for Health and Care Research Wales NHS Research time award and the PhD studentship scheme. She regularly reviews for a number of journals and various NIHR and HCRW funding panels

NORTH CTU has been collaborating, designing, analysing and disseminating health research across a wide breadth of clinical specialities since 2007. Over that time we have seen a huge shift in the types of data and the way we collect, manage and analyse this. Especially since the advent of COVID we have seen a step change within the type of health interventions being offered – online and digital options being particularly popular currently, the movement of study management to online and digital options, and a focus on improving the efficiency of running these types of trials.

At NWOORTH we have a particular interest in complex interventions, those that look at psychosocial interventions or service delivery models. We have experience of trials, looking at efficiencies and benefits of delivering health systems in alternative ways (e.g. SENIOR, TOPIC, HT pilot). Running these types of trials within the restrictions of a randomised controlled trial can be complex. The practicalities of service delivery versus required study rigour can mean that evaluations can fall over before they begin.

We will explore the ways trials, trial delivery and the context within which we are delivering these studies is has changed over the years. We will then look to explore the current landscape of trial design and methodologies that are becoming available to us, this includes the expanded use of electronic health records and synthetic data to provide a wealth of data. The balancing of service evaluation versus research in terms of developing ideas. Implementing these methods into the pragmatic trials which generate messy real world data will require time and understanding from health research funders, the researchers (both clinical and academic), those on the ground delivering this work and importantly the patient and public (PPIE) voice.

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improve the methodology and conduct of clinical trials

Talia Isaacs, Sharon Love, Matthew Sydes, Dr Victoria Yorke-Edwards, Shiva Taheri
Parallel 3 - Health & Social Care, LR2, September 10, 2024, 14:10 - 15:10

Biography:

Shiva is currently a second year PhD student at the MRC Clinical Trials Unit part of the Institute of Clinical Trials and Methodology (ICTM) University College London, focusing on improving monitoring in clinical trials through the development of evidence and tools. As part of her research, Shiva has created a Trial Monitoring Plan template intended for use by all UK Clinical Trial Units. She is actively testing and validating the template by piloting it with various Clinical Trial Units and conducting qualitative interviews and thematic analysis on the experience of using the template. Additionally, she is also investigating the effect of monitoring actions on the metrics used in clinical trials.

Prior to embarking on her PhD journey, Shiva was a Trial Manager for several years. In this role, she successfully oversaw the setup, execution, and completion of a portfolio of studies, ensuring compliance with the protocol, the UK Research Governance Framework, Good Clinical Practice, as well as sponsor and unit's SOPs. Shiva played a key role in developing a cohesive team of research coordinators, data managers, research nurses, and research fellows. Additionally, she actively participated in the development of numerous grant applications for the unit.

Clinical trials play a crucial role in leading healthcare systems, emphasising the need for high-quality research with effective quality control processes. Monitoring, an important element, ensures participant safety, rights, and trial integrity.

Currently in the UK, each Clinical Trial Unit (CTU) develops its own monitoring plan based on the unit's Standard Operating Procedures (SOP)s, Good Clinical Practice (GCP) guidelines, regulatory requirements, and with input from a small number of experienced staff. There is considerable variation in how CTUs create their monitoring plans. This highlights the necessity for a standardised template accessible to all, ensuring widespread benefits across CTUs. Moreover, monitoring clinical trials needs to be streamlined as other processes have been, such as guidelines for clinical trials protocols and statistical analysis plans. As part of this project a new Trial Monitoring Plan (TMP) template has been developed with input from many experienced individuals in monitoring clinical trials.

This study aims to determine whether a Trial Monitoring Plan (TMP) template, is effective in clinical trial monitoring practices within UK CTUs using qualitative research methods. The newly developed TMP template was tested and validated using one to one instant reaction qualitative interviews. Interview participants were given the opportunity to review the TMP template, before being asked a series of questions followed by an in-depth discussion about their insight on the TMP template. Thematic analysis was used to analyse the results of the interviews. Twelve instant reaction qualitative interviews were conducted with experienced individuals from 9 UK CTUs. Interviews were digitally recorded via Microsoft Teams and automatically transcribed. Thematic analyses were used to analyse the data and create themes and mind maps. The themes aimed to determine whether the TMP template is clear, understandable, easy to use, different to current monitoring plans in use and usable for future trials.

The template is adaptable to different trials and is expected to be used in conjunction with CTU's SOPs, trial protocols, and other sponsor-related documents. Implementing this template has the potential to enhance transparency, completeness, and standardisation in monitoring practices, benefiting investigators, participants, future patients, and healthcare systems. The template's future availability via open access aims to further promote its widespread adoption. The template's efficacy is validated through qualitative interviews, and participant feedback, ensuring it aligns with the intended purposes. This study showed that testing and analysis of any new instrument can be a valuable process to establish the evidence-based efficacy of the instrument.

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Application of Markov Queue with Three Waiting Rooms in the CT Scan Center Using Fuzzy Analysis

Ms Antala Khushbu Shantilal, Dr. Sudeep Singh Sanga

Sardar Vallabhbhai National Institute Of Technology

Parallel 5 -Health & Social Care, Greek Room, September 11, 2024, 11:00 - 12:30

Biography:

Khushbu Antala is a dedicated research scholar pursuing her PhD at SVNIT Surat, Gujarat, India, under the guidance of Dr. Sudeep Singh Sanga. Since joining the program in December 2021, Khushbu has focused her research on queueing models with control policy, soft computing, optimization, and machine learning.

Khushbu has already achieved significant milestones in her academic career, co-authoring two research papers published in renowned journals like the Journal of Computational and Applied Mathematics, Elsevier, and the Applied Soft Computing Journal, Elsevier. With her strong work ethic and passion for innovation, Khushbu is poised to make valuable contributions to the field of queueing theory and its applications.

I have achieved significant milestones in her academic career, co-authoring two research papers published in renowned journals like JMCM and the Applied Soft Computing Journal. With my strong work ethic and passion for innovation, I am poised to make valuable contributions to the field of queueing theory and its applications.

The paper proposes a single-server queueing model with a triple orbit and an unreliable server to study the model's performance in the healthcare sector, particularly in the CT scan center, where patients' CT scan is done by a single radiologist. In this context, the CT scan machine functions as the server, while awaiting patients are referred to as customers. To construct the mathematical model, we develop the Chapman-Kolmogorov (C-K) steady-state equations and derive the steady-state queue size probabilities and the queue length of patients, waiting time, and server utilization in the presence of server breakdown. Subsequently, the model undergoes a transformation into a fuzzy environment, with input parameters represented as trapezoidal fuzzy numbers. Leveraging Zadeh's extension principle, the α -cut method is employed to formulate a series of parametric nonlinear programming (P-NLP) problems for fuzzified system indices, which are then evaluated using differential calculus techniques. The numerical results are presented, which show that the proposed fuzzy queueing model can provide more accurate and realistic predictions of the system's performance compared to traditional queueing models. Furthermore, the model is applied to analyze the performance of a CT scan center across various scenarios.

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Voucher Effect in Appointment Based Queues

Dr Ahmad Reza Pourghaderi¹, Dr Boray Huang², Dr Wee Meng Yeo³

¹Monash University, ²University of Dundee, ³University of Glasgow

Parallel 5 -Health & Social Care, Greek Room, September 11, 2024, 11:00 - 12:30

Biography:

Wee Meng joined the Adam Smith Business School in January 2018. He is interested in pursuing practice-inspired research and teaching in operations management.

Prior to joining University of Glasgow, he was a research scientist at the Singapore Institute of Manufacturing Technology. In his former role, he was involved in industry-assist projects such as software development and training in the areas of demand forecasting and inventory planning.

He also held postdoctoral position at Georgia Institute of Technology, and was a member of the adjunct faculty with Singapore Management University.

Sequencing arrivals is known to be important but exceedingly challenging in appointment systems. Up to date, very few structural results have been derived to depict the dynamics in sequencing job/job arrivals. Most researches therefore turn to the shortest expected processing time first rule (SEPT) or the smallest variance first rule (SVF) by conjecture or showing their optimality under various assumptions with limited clear explanations. The intuition behind the SEPT/SVF rule is based on the propagation effect: A delay of an early job may cause a late start of its subsequent job and propagate the tardiness. In the appointment-based queues, however, we find a voucher effect which counteracts the propagation effect in total waiting time, making the SEPT/SVF rule sub-optimal in general cases. The voucher effect is further investigated in an appointment-based queue with two classes of jobs whose excess times are stochastically ordered. We show structural properties of the optimal sequence and identify the impact of the voucher effect when the total job waiting time is minimized.

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Designing Resilient Medicines Supply Chains - A Shortages Prediction Model

Vincent Hargaden¹, Abu Shakil Ahmed¹, Sean McGarraghy¹, Nikolaos Papakostas¹

¹University College Dublin

Parallel 5 -Health & Social Care, Greek Room, September 11, 2024, 11:00 - 12:30

Biography:

Vincent Hargaden is Head of the University College Dublin School of Mechanical and Materials Engineering. Since joining the School in 2011, he has served as the director of the UCD Master of Engineering Management, an executive level programme for industry practitioners. He is the founding head of the Systems Engineering subject area within UCD. From 2004-2011 he taught at UCD Michael Smurfit Graduate Business School. From 1997-2004 he held a number of roles in industry in project engineering, quality and supply chain management. His teaching interests cover the mathematical aspects of Operations and Supply Chain Management, which includes modules in Supply Chain Design, Operations Strategy, Decision Analysis and Project Management. Vincent's research focuses on the design and optimisation of resilient supply chains, Industry 4.0 and on engineering education. He is technical director of the Laboratory for Advanced Manufacturing

Simulation & Robotics (LAMS) and principal investigator on a number of nationally and internationally funded research projects.

This research develops an initial data-driven framework for prediction of shortages in medicines supply chains. It starts with acquiring publicly available medicines shortages data. Pre-processing steps include dimensionality reduction, label encoding and text pre-processing. Additionally, feature engineering is applied to the temporal features to capture seasonal trends. The dataset is expanded by bootstrapping. The predictive model is refined through hyperparameter tuning, feature selection and time-series cross-validation. The performance is evaluated using several accuracy metrics such as mean absolute error (MAE), mean squared error (MSE), root mean squared error (RMSE), r-squared (r^2), and explained variance. The results from this initial model underscore the importance of the availability of more extensive historical shortage data through reporting, larger sample sizes and diverse features for better prediction of medicines shortages to enable more resilient medicines supply chains.

Leadership Engagement Acceleration & Partnership (LEAP): A Digital Health Hub for the South West and Wales

Ian Craddock, Andrew Dowsey, David Ellis, Professor Daniel Gartner, Hanna Isotalus, Maneesh Kumar, Richard Luxton, Martin Pitt, Prof. Paul Harper, Prof Christos Vasilakis
Parallel 6 - Health & Social Care, Greek Room, September 11, 2024, 13:30 - 15:00

The Digital Health Hub, funded by UK's Engineering and Physical Sciences Research Council, is a collaborative initiative in the South West of England and Wales bringing together leading universities, supporting companies, National Health Service Trusts, and social care organizations to create a dynamic ecosystem for training, research, and collaboration.

The hub has three pillars. Firstly, the Hub's Skills and Knowledge Programme responds to the professional training needs of industry, health and social care providers, and academia, focusing on two key themes: Transforming Health and Care Beyond the Hospital, and Optimizing Disease Prediction, Diagnosis, and Intervention. The aim is to develop the necessary skills and expertise to drive innovation and deliver effective digital healthcare solutions.

Secondly, the Hub's Fellowship programme nurtures future leaders across academia, industry, health and care sectors, and the wider community. With five different schemes, it offers a platform for aspiring leaders to influence the future of digital health.

Finally, the Hub's Research programme focuses on advancing pre-competitive research within the transformative areas of healthcare. By collaborating with organizations, the Hub ensures that research efforts align with current health priorities and add value to the healthcare landscape. Our presentation provides an overview of the £3.2 million three-year programme.

Keywords

- Analytics and Data Science
- Health Care

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Real-time demand-driven inventory management in a hospital pharmacy

Ali Jafari^{1,2,3}, Antoine Legrain^{1,2,3}, Nadia Lahrichi^{1,2}

¹Polytechnique Montreal, ²CIRRELT, ³GERAD

Parallel 6 - Health & Social Care, Greek Room, September 11, 2024, 13:30 - 15:00

Biography:

I am a PhD candidate in the Department of Mathematics & Industrial Engineering at Polytechnique Montreal University. My research focuses on the application of operations research to healthcare systems, specifically on optimizing hospital inventory systems. Collaborating with the Centre Hospitalier de l'Université de Montréal (CHUM), my PhD projects delve into optimizing hospital inventory management. The first project involves developing a hybrid inventory policy for managing medications in hospital wards, while the second project concentrates on inventory management of high-volume, low-cost medical supplies within the hospital.

Hospital pharmacies receive thousands of prescriptions per day, consequently, it is crucial that the hospital medication circuit be as optimal as possible. Nevertheless, hospital inventory management is highly complex for various reasons, including space limitations, demand uncertainty, and human resource limitations. Furthermore, the inventory policy must be adaptable to real-time fluctuations in patient demands, with a simultaneous emphasis on preventing backorders and stockouts, given their potential to harm patients' well-being.

Additionally, it is not operationally effective for care units (CUs) to repeatedly request new supplies every day to avert situations of insufficient stock. To address this problem, we present a real-time inventory control model based on the characteristics of medication demand while considering uncertainty in demand and space limitations, with the main objective of minimizing CU replenishment frequency. First, we categorize the medications into two groups; fast-moving and slow-moving medications, then, we utilize a continuous and dynamic review inventory control policy for these categories respectively. For optimizing the inventory control parameters we propose a stochastic optimization model for each category. To efficiently solve the proposed inventory policy in real-time, we employ a receding-horizon control (RHC) strategy, where the models are solved iteratively over a predetermined time horizon. To validate the effectiveness of our proposed approach, we use a real-world inventory management setting for a hospital in Montréal and conduct a comparative analysis between the proposed model and the existing state of the inventory policy to demonstrate the advantages of this research.

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Sequential Pattern Mining for Learning Clinical Pathways

Mr. Matthew Howells¹, Prof. Paul Harper¹, Professor Daniel Gartner¹, Dr. Geraint Palmer¹, Mr. Antonio Riccioli²

¹Cardiff University, ²Cardiff & Vale University Health Board

Parallel 6 - Health & Social Care, Greek Room, September 11, 2024, 13:30 - 15:00

Biography:

Matthew Howells is a PhD student in Operational Research at Cardiff University. Currently, his research applies simulation and pattern mining techniques to model a Trauma & Orthopaedic pathway at Cardiff & Vale University Health Board.

Clinical pathways (CPs) can be viewed as structured processes designed to standardise healthcare processes, that outline the essential steps in the management of a particular health condition or medical procedure. Sequential pattern mining is a technique to learn temporal relationships from transactional data, making it useful in learning significant CPs from healthcare datasets.

This work presents an implementation of the ALERGIA algorithm in Python, to generalise CPs obtained from a Trauma & Orthopaedics patient dataset in Cardiff & Vale University Health Board. Doing so, we are able to allow for the inclusion of potential CPs that may not have been explicitly observed in the dataset. Furthermore, the algorithm aids in filtering out pathways considered statistically insignificant, enhancing the robustness and relevance of the extracted CPs.

The application of this algorithm to a real-world CP dataset offers valuable insights into the optimisation and standardisation of care processes for healthcare researchers and management. Learning these significant CPs to help standardise care can lead to enhanced patient outcomes and more efficient resource allocation in clinical settings. We further present how these CPs will be used to parametrise a discrete-event simulation of a holistic orthopaedic surgical pathway, which as a whole will enable staff to make informed decisions on demand and capacity planning.

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Joint analytical problem solving: the NHS Wales Modelling Collaborative

Dr Jennifer Morgan

Parallel 7 - Health & Social Care, LR2, September 12, 2024, 09:00 - 10:30

Biography:

Dr Jennifer Morgan is an Operational Researcher, with 19 years of experience of modelling to support planning and delivery in health and care. She holds a PhD in Mixed Methods Modelling (Discrete Event Simulation and System Dynamics) and works at the NHS Wales Executive (NHSWE), Data & Analytics Function. Since 2018 she has chaired the NHS Wales Modelling Collaborative – a networking group to promote using modelling and analytics to support planning, and facilitate the

sharing of good practice, tools and insights across health and care in Wales. Prior to working in NHSWE, she worked at Cardiff University School of Mathematics as an embedded researcher with Cardiff and Vale University Health Board using modelling to inform decision making, applying research into practice.

Operational Research (OR) modelling in Health and Care is not new, but there remain challenges resourcing, delivering, embedding, and implementing models. The NHS Wales Modelling Collaborative (WMC) aims to improve the use of OR, modelling and analytical techniques across Health and Care by coordinating efforts, sharing methodologies, and promoting best practices. Its primary mission is to accelerate and expand successful modelling initiatives to transform data into actionable knowledge for better decision-making and patient care. The WMC ran an action research programme of projects between 2019 and 2024, to connect modellers with decision-makers and academics, foster a safe environment for problem-solving, encouraging innovation, and improving care through enhanced data-driven decision-making. This presentation shares highlights from three projects: Simulation modelling critical care, workforce pathway analytics and text analysis of nationally reportable incidents. The lessons learnt from the programme and the next phase for the WMC to build a robust foundation for modelling in healthcare across Wales, contributing to more informed planning and service provision will be discussed

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Enhancing Behavioural Anomaly Detection Under Concept Drift within Healthcare Sector: Application of Change Point Detection and Batch Learning

Mr. Cho Ching Wong, Prof. Richard Allmendinger, Dr Arijit De
Alliance Manchester Business School, University of Manchester
Parallel 7 - Health & Social Care, LR2, September 12, 2024, 09:00 - 10:30

Biography:

Arijit De is currently working as an Assistant Professor at The University of Manchester. He is an Industrial and Systems Engineer, Operations Research Scientist and Management Science Lecturer.

Arijit has authored 18 technical papers in International Journals (peer-reviewed) such as European Journal of Operational Research, Transportation Research Part E: Logistics and Transportation Review, International Journal of Production Economics, Transportation Research Part D: Transport and Environment, IEEE Transactions on Intelligent Transportation Systems, IEEE Transactions on Engineering Management, International Journal of Production Research, Annals of Operations Research, Computers and Industrial Engineering, Expert Systems with Applications and Engineering Applications of Artificial Intelligence. Arijit De received his Ph.D. in Industrial & Systems Engineering and M.Tech in Industrial Engineering and Management. Arijit holds the

Fellow of Higher Education Academy (FHEA). Arijit is a Chartered Professional, holding the Chartered Membership (CMILT) with The Chartered Institute of Logistics and Transport.

Previously, Arijit was associated as a Co-Investigator - Operations Research Expert with VALUMICS_H2020. He also worked as a Lecturer (Assistant Professor) in Operations Management at Newcastle University Business School, Newcastle University.

Prior to this, Arijit worked as a Project Researcher in the School of Business and Economics, Loughborough University. Furthermore, he worked at the Department of Industrial & Systems Engineering, Indian Institute of Technology Kharagpur and Department of Industrial and Manufacturing Systems Engineering, The University of Hong Kong.

The global challenge of an aging population has become increasingly prominent due to the extension of life expectancy. By 2030, approximately one in six people will be aged 60 years or older, a proportion projected to grow to 22% by 2050. This has posed burden to the healthcare sector, especially to the domiciliary care services as most elderly individuals prefer to remain in their own homes rather than care homes for their living managements. Recently, smart home devices have been employed to facilitate assisted living for vulnerable segments of society and these devices generate a lot of real-time data which if thoroughly analyzed can help in detection of abnormal behaviour.

Abnormal behaviour refers to actions diverging from an occupant's usual lifestyle pattern, such as prolonged duration for using the toilet, and sleeping disturbance. Detecting such behaviour enables intervention by domiciliary caregivers, which is beneficial for early diagnosis of conditions. Although, the dynamic nature of human behaviour poses challenges for developing a robust behavioural anomaly detection model.

In this comprehensive experimental study, the challenges of identifying anomalies in human behaviour under concept drift is examined. Furthermore, the potential enhancement of discriminative power in behavioural anomaly detection models is explored through Change Point Detection (CPD) and batch learning drift adaptation. The experiment involves the selection of Density-Based Spatial Clustering of Applications with Noise (DBSCAN) and Autoencoder. The investigation employs the Aruba real-world dataset obtained from Centre for Advanced Studies in Adaptive Systems (CASAS) at Washington State University.

Results demonstrate that the proposed approach surpasses the baseline of no adaptation, yielding an average improvement of 10.46% for DBSCAN, with a performance 3.96% points higher than the benchmark regular adaptation. Similarly, Autoencoder achieves an average improvement of 4.01%, with a performance 4.11% points higher than the benchmark. The findings suggest the need for increased attention to address concept drift in behavioural anomaly detection and

highlight the potential benefits of integrating this novel approach into existing frameworks to enhance detection capabilities in the presence of concept drift.

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Data-Driven Exploration of National Health Service Talking

Therapies Care Pathways Using Process Mining

Prof Christos Vasilakis, Elizabeth Yardley, Dr Alice Davis²

University Of Bath, 2Mayden

Parallel 7 - Health & Social Care, LR2, September 12, 2024, 09:00 - 10:30

Biography:

I am an academic scholar in Operational Research/Management Science conducting analytical rigorous but highly applied research that generates both academic and practical impact. Working in close collaboration with clinicians and healthcare professionals I develop and apply rigorous methods to help better plan and deliver care services. I am also interested in the evaluation of the likely impact of healthcare interventions and policy initiatives using mathematical modelling and computer simulation. More recently, I have (humbly) ventured into qualitative and ethnographic research methods as and when appropriate.

I have worked on a large number of problems in health and care ranging from the monitoring of surgical site infections to the organisation of care services for patients with acute stroke, glaucoma, common mental health problems, and vague symptoms of cancer. Recent work includes a number modelling studies in the context of intensive care units during the Covid19 pandemic (impact of capacity on avoidable deaths, impact of admission criteria on lives and life-years lost), evaluating strategies of blood provision following mass casualty events and facility location analysis for maternity services.

The NHS Talking Therapies (TT) programme in England follows a "stepped care" approach for treating patients with common mental health problems, where effective but less resource intensive treatments are delivered to patients first and more intensive interventions are provided only if required. Limited resources and pressure to achieve service standards mean that program providers are exploring ways of evaluating and improving the flow of patients through their service. Research evidence points to variation in clinical performance and how stepped care has been implemented across organisations, and has identified associations between service delivery and patient outcomes.

Process mining offers a data-driven approach to analysing and evaluating health care processes and systems, enabling comparison of presumed models of service delivery and their actual implementation in practice. The value and utility of applying process mining to NHS Talking Therapies data for the analysis of care pathways is not well understood.

We aim at developing innovative, advanced, analytical tools to help improve understanding and management of NHS TT services' demand and capacity. In this study, anonymised individual patient referral records from iaptus, the leading digital care record for psychological therapy services, to explore and model patient flows through talking therapy care pathways using process mining and other data-driven methods, to evaluate pathway performance and explore relationships between system performance and patient outcomes. Our findings demonstrate how process mining can be applied to Talking Therapies care pathways to highlight systemic issues, such as 'stepping up' care being actually relatively uncommon within a stepped care system

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Which way to fly? Machine learning for expert-assisted decision support in emergency medical retrieval services

Dr Laura Boyle

Queen's University Belfast

Parallel 8 - Health & Social Care, LR2, September 12, 2024, 11:00 - 12:30

Biography:

Laura Boyle is an Lecturer in Data Analytics in the Mathematical Sciences Research Centre at Queen's University Belfast and an adjunct lecturer in the School of Computer and Mathematical Sciences at the University of Adelaide, Australia. Her research interests include simulation, data analytics, and operational research with applications in healthcare.

When a medical emergency strikes, we want help to arrive as fast as possible - even when we are far from home. In highly complex and/or distant emergencies, optimising the time to successfully retrieve a patient is not always as straight-forward as sending the fastest moving vehicle. Impacts on retrieval time can include finding a place to land an airplane, getting from the landing site to the emergency location and back, or getting an ambulance through peak hour on major arterial highways to the city-fringe and beyond. Usually, the selection of what transport to send to an emergency falls to a team of expert decision makers who swiftly look at the complex details of an event and make a choice. They can be asked to take in huge numbers of details to make this decision, relying on the lived experience of their previous decisions, and those of their team, to make the best choice. In many cases this decision-making process is straightforward, however, there are complex cases in which there is some ambiguity around the most efficient medical team composition and transport method for complicated locations or scenarios, where decision makers may disagree on the best solution.

This research presents a four-stage data-driven RetrieveD framework for assisting with emergency medical services decision support with multiple vehicle types. The framework uses predictive modelling and visual analytics to present a set of options to the decision maker, based on similar historical cases and from the live information available at dispatch time. In this approach, a full

range of options is presented to support the decision maker, rather than providing a prescriptive solution. Figure 1 presents the structure of the framework, which consists of four parts: (i) Data collection, management, and cleaning, (ii) Distance definitions and calculations, (iii) Design of appropriate models, and (iv) Decision support implemented with an expert-in-the-loop mentality.

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Real-time, short horizon predictions of emergency department load: A time series story.

Mr. Michael Ucci¹, Dr Laura Boyle², Dr Melissa Humphries¹

¹The University Of Adelaide, ²Queens University

Parallel 8 - Health & Social Care, LR2, September 12, 2024, 11:00 - 12:30

Biography:

Dr. Melissa Humphries is a statistician – she creates, and applies, analytical tools that make sense of our world. Working in areas like forensic science, health and psychology, the goal is always to increase efficiency, accuracy, and transparency. Building bridges between machines and experts, Melissa's work aims to support experts in making decisions in an explainable way.

Working at the interface between statistics and AI, Melissa's research draws meaning out of complex systems by leveraging the explainable components of statistical and physical models and elevating them using novel techniques. She strongly advocates the integration of the end-user from the outset of all research and is committed to finding impactful ways to implement science.

Melissa is also a passionate advocate of equity across all areas of her work and life.

On a global scale, hospital Emergency Departments (EDs) are experiencing increasing rates of overcrowding. Mathematical methods and analyses have proven to be powerful tools against ED overcrowding, the most popular including simulation models, queueing theory and statistical analyses. That said, limited work has investigated the use of generalised models for the purposes of multi-hour demand prediction. Through utilisation of publicly available, real-time data from six South Australian EDs, we have been able to build a predictive model of demand at short horizons. Using time series analysis, the model was shown to consistently outperform a forecasting baseline in all six EDs and produced results comparable to readily implemented deep learning approaches, but at a fraction of the computational cost.

This talk will cover development of the model, including the cross-validation methodology for time series that was developed, and present a working version of an app interface that could be used for interaction with the model in real time.

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Novel optimisation algorithms for location allocation problems in healthcare

Dr Mark Tuson, Professor Owen Jones, Elizabeth Williams
Cardiff University

Parallel 9 - Health & Social Care, LR2, September 12, 2024, 13:30 - 15:00

Biography:

My current role sees me splitting my time between Cardiff University and Cardiff and Vale University Health Board. This means I spend half my time lecturing and researching and the other half putting what I teach into practise.

I'm a relatively late entrant into academia having completed my PhD in 2020. I started my career in the Forces and subsequent worked in manufacturing industries and then the public sector before completing a PhD in operational research.

I have travelled extensively or worked abroad for most of my career and one of the things I really enjoy about the academic environment is the cultural diversity of my colleagues and students. 'Location – allocation' problems are common in healthcare related OR. Examples include ambulance allocation in large urban areas, siting of specialist clinics in the context of regional demand, and management and storage of vaccines. They are often addressed with a bespoke heuristic algorithm which seeks to establish the 'value' of a specific allocation/solution and an optimisation algorithm that seeks to optimise the allocation to maximise the 'value'.

We present two novel optimisation algorithms utilising concepts from cross-entropy and estimation of distribution approaches, to address constrained non-linear optimisation problems of this sort.

Having described the algorithm, we present benchmarking data comparing the performance of our algorithm with that of alternative established optimisation approaches for this type of problem (derived from healthcare literature) and using real data seek to quantify the impact of those algorithms on patient outcomes.

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Investigating Unscheduled Attendances in an Emergency Department in Northern Ireland using Process Mining

Peter Cosgrove, Christine Kennedy, Professor Adele Marshall, Danny McWilliams

Parallel 9 - Health & Social Care, LR2, September 12, 2024, 13:30 - 15:00

Biography:

Professor Adele Marshall is Professor of Statistics at Queen's University Belfast, Adjunct Professor at Ontario Tech University, with expertise in the fields of statistical modelling, advanced data analytics and decision making under uncertainty primarily applied in healthcare. Adele has 25 years research experience evidenced through over 200 authored publications. She enjoys working on multidisciplinary research projects and dealing with the challenge of real-life problems and real data.

Emergency departments (EDs) globally are experiencing high levels of increasing demand and overcrowding. UK EDs, in particular since the COVID pandemic, have seen increasingly high pressures on resources and staff fuelled by challenges accessing routine services. Northern Ireland EDs have described excess patient mortality due to overcrowding and increasing four-hour waiting time benchmarking from 28.2% in January 2013 to 56.6% in September 2023.

Previous research has demonstrated the effectiveness of modelling patient waiting times in ED and length of stay in hospital using a special type of Markov model known as the Coxian phase-type distribution that describes duration until an event occurs in terms of a process consisting of phases. In these examples, the Coxian phase-type distribution was used to classify patient time into different phases of care or waiting where patients in a particular phase had similar patient characteristics. Advances in data collection and accuracy now presents new challenges for process modelling patient flow through the ED system.

This research uses routinely collected ED data for unscheduled attendances and admissions for patients arriving to ED during 2022-2023 and applies advanced analytics, and processing mining including Coxian phase-type clustering to identify key characteristics for unscheduled pressures. The approach provides an understanding of flow of unscheduled care in the ED and a method for identifying clusters of patient-types who present at the ED. The characteristics can also be linked with each patient type, waiting time distribution in ED and subsequent stay in hospital and may be used to cost-effectively redistribute the allocation of resources to high-yield areas and to model future planning scenarios.

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Performance assessment of GP surgeries in England

Dr Colin Stewart

More Metrics

Parallel 9 - Health & Social Care, LR2, September 12, 2024, 13:30 - 15:00

Biography:

For the last 40 years Colin's career has been built around using analytics to solve business problems. Colin has run teams across the different sectors of the banking industry. Working

independently since 2010 with insurance and other clients Colin has developed the new ways of using open source data and spatial analysis techniques that underpin More Metric models. This talk will provide an update on the pro-bono work that is being undertaken by More Metrics investigating the options for assessing GP surgery performance using open source data.

Previous work has investigated whether GP surgery diagnosis rates (controlled for age, sex and population health) together with estimates for the level of staff resource (controlled for patient list size and need index) can be used as a useful measure of GP performance.

This analysis has shown some promise, but is not straightforward because of the wide variation of staff resourcing mix seen across the GP network. For example, the ratio of doctors to patients, and the mix of doctor grades varies greatly across the network. This variation is not systematically linked to external factors (such as list size or community deprivation levels) which suggests that there is an opportunity to use performance analysis to identify which GP resourcing models offer the best support to patients at a suitable economic cost for the taxpayer.

To progress this opportunity we are currently investigating the best way of segmenting GP practices by resourcing mix and patient characteristics to provide a more robust framework for GP surgery performance assessment.

This talk will provide an update on progress, with an emphasis on how this type of analysis might be developed to support the work of integrated care boards (ICB)

Hybrid Modelling and Simulation

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Hybrid Modelling Using Data Science and Modelling & Simulation Techniques: A Review

Mr. Ali Ahmadi, Dr Masoud Fakhimi, Dr Carin Magnusson

University Of Surrey

Parallel 2 - Hybrid Modelling and Simulation, The R. Willims Parry (OSCRA), September 10, 2024,
13:00 - 14:00

Biography:

Ali Ahmadi is a first-year PhD student at the University of Surrey. His research involves implementing a data science approach to modelling and simulation to develop innovative solutions for improving healthcare delivery systems.

The fields of Modelling & Simulation (M&S) and Data Science (DS) have witnessed rapid growth and development, paving the way for advancements and transformative applications across various industries. Over the past few years, these disciplines have become integral to solving complex problems, optimising processes, and making data-driven decisions. The Hybrid M&S-DS approach, leveraging the unique strengths of both M&S and DS, holds promise for improving model precision, enhancing efficiency, and refining decision-making processes. This review examines the prevalence and utilisation of combining DS techniques—like machine learning and artificial intelligence—with traditional M&S methods such as Agent-Based Simulation (ABS), Discrete Event Simulation (DES), and System Dynamics (SD) in the healthcare context. Through an in-depth review of 69 relevant papers, we contribute to a comprehensive understanding of the current state-of-the-art in Hybrid M&S-DS as applied to healthcare. The review encompasses a categorisation of M&S and DS methodologies, and a thorough exploration of application types, types of hybridisation, software packages, machine learning algorithms, programming languages, emerging trends, potential opportunities, and challenges associated with Hybrid M&S-DS in healthcare. The results of our review highlight the significant potential of Hybrid M&S-DS in healthcare, with broad applicability across diverse areas including the emergency department, infectious disease, and patient flow modelling. Furthermore, this review critically assesses the gaps in the current literature and suggests directions for future research within this domain.

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A MATURITY MODEL FOR DIGITAL TWINS IN HEALTHCARE

Professor Navonil Mustafee¹, Dr Alison Harper¹, Dr Joe Viana², Dr Tom Monks³

¹University of Exeter Business School, ²BI Norwegian Business School, ³University of Exeter Medical School

Parallel 2 - Hybrid Modelling and Simulation, The R. Willims Parry (OSCRA), September 10, 2024, 13:00 - 14:00

Biography:

NAVONIL MUSTAFEE is Professor of Analytics and Operations Management at the University of Exeter Business School, UK. His research focuses on modelling and simulation methodologies, including hybrid modelling and real-time simulation, and their application in healthcare, supply chain management, circular economy and climate change adaptation and resilience. He is a Joint Editor-in-Chief of the Journal of Simulation (UK OR Society journal) and leads the JOS Africa Focus initiative.

Digital models, digital shadows, and digital twins (DTs) are increasingly used in manufacturing/Industry 4.0 to represent levels of integration between physical systems and their digital counterparts; data-flow mechanisms are the enablers of such integration. Healthcare operations management has also witnessed rising interest in hybrid models that use real-time data to increase situational awareness (SA) and enable short-term decision-making. In M&S literature, such models are referred to as Real-time Simulations (RtS) and DTs. Healthcare organizations can realize a heightened state of SA by transitioning from conventional modeling to RtS/DTs. The paper presents a Maturity Model for DTs to contextualize the increasing levels of healthcare Information Systems/Information Technology (IS/IT) integration with real-time models that such a shift will necessitate. The higher the Maturity Level of IS/IT integration, the greater the opportunity to develop modeling artifacts that realize the potential of real-time data and enable organizations to attain higher levels of SA.

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Leveraging Model Reusability for Hybrid Simulation in Healthcare

Mr Eyup Kar¹, Dr Masoud Fakhimi¹, Dr Christopher Turner¹, Professor Tillal Eldabi²

¹University Of Surrey, ²University of Bradford

Parallel 7 - Hybrid Modelling and Simulation, Greek Room, September 12, 2024, 09:00 - 10:30

Biography:

Eyup Kar is a PhD candidate at Surrey Business School, University of Surrey. His research focuses on hybrid simulation modelling in healthcare. You can contact him at e.kar@surrey.ac.uk. Healthcare challenges are inherently complex, necessitating robust and multifaceted solutions. While traditional modelling and simulation (M&S) methods can effectively capture the dynamic aspects of healthcare systems, they often struggle to fully address the various levels—macro, micro, and individual—of these systems. A hybrid simulation approach that integrates discrete event simulation (DES), system dynamics (SD), and agent-based simulation (ABS) addresses these challenges by providing a comprehensive view and facilitating effective interventions in complex healthcare scenarios. Developing hybrid simulations, however, presents significant challenges as it usually requires expertise across various M&S methodologies, a considerable time commitment,

and substantial resources. Furthermore, integrating different simulation models usually necessitates advanced coding skills, complicating the development process. Instead of starting from scratch, leveraging model reusability offers a practical and efficient alternative. Model reusability involves using pre-existing models, which can significantly reduce both the time and cost associated with developing new simulations. This research highlights the significance of model reusability, particularly DES or SD, to enhance the efficiency of developing new hybrid simulations. It discusses critical factors such as generalisability and reproducibility, which are crucial for creating adaptable models that can be reused in different contexts, thus mitigating development challenges and reducing the costs associated with hybrid simulation.

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A Conceptual Modelling and Simulation Framework for Incorporating Sustainability, Circular Economy, and Resiliency Factors in the Modelling of Healthcare Supply Chains

Mrs Fatemeh Alidoost, Professor Navonil Mustafee

University of Exeter

Parallel 7 - Hybrid Modelling and Simulation, Greek Room, September 12, 2024, 09:00 - 10:30

Biography:

PGR at the University of Exeter Business School

Sustainability, with its emphasis on environmental, social, and economic considerations, strives for the long-term viability of healthcare systems. The Circular Economy (CE) as sustainability practice shifts away from the notion of 'end-of-life' by prioritising the reduction, reuse, recycling, and recovery of materials. The dynamic capabilities to anticipate, withstand, and recover from disruptions while maintaining essential healthcare services through SCM practices is referred to as resilience. Organisations often need to make informed decision-making processes to balance sustainability, circular economy, and resilience goals. For instance, the interventions to maintain system resilience such as stockpiling, may come at the expense of economic and environmental objectives. Moreover, given the varying perspectives on the relationship between sustainability and CE (conditional, beneficial, or involving trade-off relationships), investigating the impact of CE on sustainability and resilience in healthcare supply chains (HSCs) has yet to become an established practice. Modelling HSCs involves considering the unique complexity and dynamics, such as high variability and uncertainty in products and operations, perishability considerations, and the time-sensitivity of care products and services. While incorporating various and sometimes conflicting factors of economic, environmental, social, and resilience into HSC modelling is challenging, the conceptual modelling stage can play a critical role in facilitating the integration. This study addresses this gap using a hybrid approach, combining value stream mapping (VSM) and discrete event simulation (DES). The study presents a novel extension to VSM, as the conceptual model, to incorporate economic, environmental, social, and resilience factors. The implementation of the conceptual modelling framework is expected to enhance the development

of DES models that incorporate both sustainability and resilience factors. The study proposes a simulation framework model, using a case study of a hospital pharmacy, to understand the balance between these factors, evaluate the cost-effectiveness of sustainability practices (e.g. CE), and assess their impact on sustainability and resiliency of the system. Incorporating these factors enables exploring the complex interrelationships of the circular sustainable and resilient HSC within a controlled system, facilitating informed decision-making and operational planning.

Making an Impact

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Bridging the Gap: How to Deliver More Effective Knowledge Exchange Between Academia and Industry

Professor Jesse O'hanley¹, Professor Matthew Revie², Professor Miguel Anjos³, Dr Mosab Bazargani⁴

¹University of Kent, ²University of Strathclyde, ³University of Edinburgh, ⁴Bangor University
Making an Impact - Bridging the Gap: The Knowledge Exchange Initiative, LR5, September 11, 2024, 09:00 - 10:30

Biography:

Jesse O'Hanley is a Professor and Associate Dean of Research & Innovation at Kent Business School, University of Kent. Prof O'Hanley's research focuses on the development and application of optimisation and simulation techniques environmental management, facility location, and transportation/logistics. He has authored over 70 articles and other publications covering a wide range of theoretical and applied topics, much of it highly interdisciplinary in nature. Recent work has appeared in leading field journals in operational research and environmental management. Prof O'Hanley has carried out advisory and consultancy work for various government agencies, NGOs, and business in the UK and internationally. This includes leading three different Knowledge Transfer Partnerships with the Port of Dover and Eurostar on the use of simulation and business analytics techniques to reduce congestion, improve operational planning, and inform capital investment decisions. He is the 2015 winner of the EURO Excellence for his work on on-the-ground river connectivity restoration.

Whether driven by school mission, promotion aspirations, or REF, there is an ever-greater emphasis on knowledge exchange within UK universities. Successful knowledge exchange, however, does not happen by accident. This workshop aims explore the ins and out of knowledge exchange in its various forms, how to launch partnerships with industry, and deliver benefits on both sides. If you want to make your research more impactful, learn from a group of academic and industry experts who have developed compelling examples of knowledge exchange and discover strategies to foster collaboration and turn research insights into real-world results. Don't miss this series of interactive presentations and panel discussion.

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Introduction to Metaheuristics with Application to Travelling Salesman Problem in Python

Dr Mosab Bazargani¹, JOHN WOODWARD²

¹Bangor University, ²Loughborough University

Making an Impact - Metaheuristics In Python, LR2, September 11, 2024, 09:00 - 10:30

Biography:

Dr John R. Woodward received the B.Sc. degree in theoretical physics, M.S. degree in cognitive science, and Ph.D. degree in artificial intelligence from the University of Birmingham, Birmingham, U.K. He has previously led the Operational Research group at Queen Mary, University of London (<http://or.qmul.ac.uk/people.html>) and prior to that lectured at the Universities of Stirling, Nottingham and Birmingham. He was with the European Organization for Nuclear Research (CERN), Switzerland, where he conducted research into particle physics, the Royal Air Force as an Environmental Noise Scientist, and Electronic Data Systems as a Systems Engineer.

Many computational problems involve examining a large number of potential solutions to a problem. Often the number of possible solutions is vastly greater than the number of solutions we can practically evaluate. One pragmatic approach is a technique called metaheuristics.

Metaheuristics essentially sample a subset of all the possible solutions and report back with the best solution they have found.

The beauty of metaheuristics is that they are often simple to implement and return high quality solutions in a relatively short time. This is in contrast to so-called exact methods which are guaranteed to return the best solution if they terminate but the termination time might be highly unrealistic. Thus metaheuristics are a pragmatic approach to intractably large problems.

Specifically this tutorial will give some theoretical groundwork towards metaheuristics and we will then move on to a practical application: the well known travelling salesman problem. This will be done with python using jupyter notebook. This interactive tutorial will allow the audience to experiment with a data set of 70 UK cities and understand how different parameter settings affect the outcome of different metaheuristics. We will cover basic metaheuristics such as hill climbing simulated annealing and late acceptance.

One drawback of metaheuristics is they are stochastic and therefore return a different solution each time they are executed. This has given them the reputation of being inconsistent however, one item we would like to press in this tutorial is that we can fix the seed of the random number generator and simply rerun the algorithm with different parameters. This both guarantees that we return the same solution for the same parameter settings and allows us to explore the parameter setting space in order to find better solutions.

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OR@75 - The Futures of OR

Mr John Medhurst¹, Mrs Sarah Davies², Mr John Hopes³, Martin Kunc⁴, Mr Martin Parr⁵
¹Larrainzar Consulting Solutions Ltd, ²Operational Research Society, ³Heads of OR and Analytics Forum, ⁴University of Southampton, ⁵Guided Systems Solutions Ltd
Making an Impact - The Future of OR, LR4, September 11, 2024, 09:00 - 11:00

Biography:

John has almost forty years' experience of Operational Research including twenty years as an independent consultant and has specialised in extending Operational Research techniques to deal with the more challenging human elements of problems, including decision making and learning. John has an interest in systems approaches including System Dynamics and the Viable Systems Model. John also chairs the Events committee of the OR Society and has organised the Making an Impact sessions at several recent conferences.

Also presenting are:

Sarah Davies - Head of Member Engagement at the OR Society, who has 15 years experience in the non-profit sector, developing and growing new income streams and introducing new initiatives for membership growth. She is responsible for membership, training and events at the OR Society.

Martin Parr - Founder and Director at Guided Systems Solutions Ltd. Martin has worked for over 20 years as a consultant on complex projects for the UK government, industry and third sector. Martin has delivered consultancy for many government departments on big, high-risk projects and Martin is a Visiting Fellow at the Department for Education. Martin is host of the Evolving Enterprises podcast.

John Hopes is a past President of the OR Society with a long and successful career in applying OR in Management Consultancy. He is a Companion of OR and is now the Secretary of the Heads of OR and Analytics Forum (HORAF), the major industry body for OR.

Martin Kunc is Professor of Business Analytics at Southampton Business School at Southampton University and works on the intersection between management science and behavioural science with focus on the use of system dynamics to support strategic planning. He has written more than 50 articles and edited or written 4 books. He is one of the Editors-in-Chief of the Journal of the Operational Research Society.

OR@75 – The Futures of OR

The OR Society is 75 this year and to finish the year of celebrations of this achievement we will be looking forward at some of the potential Futures of OR, thinking about how the discipline might evolve over the next 25 years.

We have chosen a format which will look at several different possible aspects of the Future of OR:

The first perspective will focus on tools, methods and techniques – the question of what might be possible, presented by a current editor of JORS and Professor of Business Analytics at Southampton University.

The second perspective will focus focusing on applications and the use of OR in practice – the question of how this knowledge might be used, presented by a past President of the OR Society and current Secretary of the Heads of OR and Analytics Forum (HORAF).

Finally, the third perspective will focus on the community of people who call themselves operational researchers, how they might evolve and what they might be called – the difficult question of who we are and might become. This will be introduced by the current Head of Member Engagement at the OR Society and the Founder of Guided Systems Solutions, who has been guiding the Society through a review of its' strategy.

These will serve to set the scene for a discussion session which will allow us to gain some insight into how OR might change over the next 25 Years of the Society's existence, what technological and social factors might drive that evolution and what some of the constants might be.

This will allow those attending to understand more about what the possible futures of OR might be and how the Society is planning for them.

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Grand Challenges and OR: Dragons and Predicting Riots

Chris Roberts, Dr Miles Weaver

Edinburgh Napier University

Making an Impact - Grand Challenge, LR1, September 11, 2024, 09:00 - 10:30

Biography:

Miles is an Associate Professor in Systems, Sustainability and Supply Chains at Edinburgh Napier University.

He has chaired the "Grand Challenges and OR" session over the past decade leaving a lasting legacy of Pro Bono projects and related activity in each host city.

Each year at the OR conference, we pose a “grand challenge” pertinent to the host city, the UK, and beyond. In the past ten years offering this session, we have never been short of challenges—the climate emergency, Brexit, a pandemic, the cost-of-living crisis, and conflict in Europe and the Middle East. That is not all we have covered, and of course, we learn how deeply interconnected they all are and where OR can help.

This year in Bangor, we would be amiss without bringing in the Dragons! Not the fire-breathing kind, nor a bunch of entrepreneurs, but a football ambassador with fire in his belly. “Yma o Hyd”. We will hear from Chris Roberts, who will show how the Dragons have sought to align with the FA of Wales Sustainability Strategy 2030 and the United Nations ‘Football for the Goals’ campaign. Helping to address gender equality and reducing inequalities while supporting good health and wellbeing. The problem organisations like Chris’s face are ‘evidencing impact’, often to attract more funding. So, can OR help evidence the value of WHAT they are doing and demonstrate the values that demonstrate WHY they do so?

The second topic will focus on the recent far-right anti-immigration protests and riots that spread across England and Northern Ireland. This followed the tragedy in Southport (less than one hundred miles away), witnessing a mass stabbing with three children killed. Miles will reflect on his experience in 2011, when he and the citizens of Birmingham faced different dragons, creating chaos and destruction across the city. With the rise of social media and big data, can OR help predict a riot and its eventual diffusion?

Following the discussion, we will list potential pro bono projects, student projects, and research collaborations that we, the OR community, can take forward.

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Doom loops & eco-wars: on the frontiers of systems thinking & practice

Mr Joe Ravetz

University Of Manchester

Making an Impact -Doom Loops and Eco Wars, LR3, September 11, 2024, 09:00 - 10:30

Biography:

Joe Ravetz is the Leader of the Future-Proof Cities theme for the Manchester Urban Institute, and Co-Director of the Centre for Urban Resilience. He is author of 2 agenda setting texts: the new ‘Deeper City: collective intelligence and the pathways from smart to wise’, and the previous ‘City-region 2020: Integrated planning for a sustainable environment’.

From a long running exploration of sustainability and cognitive systems, the Synergistics methods emerged, for mapping and design of collective intelligence and transformative pathways, and the Mind-lab (Laboratory for collective intelligence), a global online community of practice.

He advises policy (UNIDO, UN-Habitat, European Commission, national governments and agencies, etc): and business, as a principal of the strategy / foresight firm SAMI Consulting. As a former architect-planner he is a keen advocate of creative visual thinking, and foresight / futures methods for strategic planning and transformation. Joe Ravetz is currently on the editorial boards of Urban Planning & Design, the Foresight Journal, and Sustainable Mediterranean Construction: and visiting professor at the Universities of Baja California, Florence and Brawijaya. He also provides reviews, evaluation, keynotes and interactive workshops in many countries.

This interactive 'MAI' workshop starts from a very topical question – how are climate tipping points linked with societal tipping points, and how could these escalate towards global conflict?

This comes from the 2-year exploration of the Eco-War 3.0 program - (<https://sites.manchester.ac.uk/synergistics/foresight-3-0-for-ww3-0/>). This was also an experiment on methods & tools suitable for (a) 'VUCA' ('volatile, uncertain, complex, ambiguous') systems: (b) 'BBW', a 'big bad world' of predatory expropriation, hijack and weaponization: and (c) cognitive / co-evolutionary systems based on 'collective intelligence'. This program of international dialogue began at the COP26, where it seemed climate policy was too easily hijacked by hegemonic colonization / conflict. Further systems thinking then framed the 'doom loop' – self-destructive reinforcing feedback, from local to global scales – as a primary focus of attention, where the 'collective intelligence' may be compromised & colonized.

The enquiry already provides unique insights for risk assessment, resilience thinking, foresight / futures, operational research and others – along with the tangible issues of climate policy, development policy etc.

This workshop aims to explore, by creative thinking and structured enquiry, the 'VUCA-BBW' challenge, the collective intelligence agenda, and practical policy applications.

For this we focus in sub-groups on 3 tangible questions:

- a) Systems methods & tools: which are the most effective for such existential doom-loop / 'VUCA-BBW' problems?
- b) Collective intelligence: how to use systems methods to promote & enhance inclusive 'wider & deeper' collective intelligence?
- c) Climate policy/ international relations: what are the implications of this for practical policy development?

Program & method:

- Introductions (10 minutes)
- Overview: 'doom loops & eco-wars' (10)
- Method & discussion (10) – structured brainstorm with combination of on-site / online
- Group work A (20): focus on problems & challenges

- Group work B (20): focus on visions & pathways
- Review & ways forward (20)

Expected 'impacts': a) structured learning outcomes: b) 'white paper' as a key contribution to the program brief & academic publications: recommendations to policy & wider governance systems.

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

Dr Christina Phillips

Liverpool Business School

Making an Impact - Human Centred Analytics, LR2, September 11, 2024, 11:00 - 12:30

Biography:

Dr Christina J Phillips, Senior Lecturer, Business Analytics, Chair of the Business Analytics Educators Forum (BAEF), Co-chair Analytics Network (ORS), Director/Trustee at The OR Society.

Christina has a first degree in Mathematics and Physical Oceanography, experience working as an analytics consultant, and won a scholarship for an industrial PhD. She has a passion for helping others gain insight from data and mathematics and this informs both her teaching and practice. HCA has been developed over 9 years of repeated application in diverse settings from UN Share the Road bike share ideation workshops to in industry production settings using a range of analytics solutions. In her spare time Christina is a creative gardener and ceramic maker of sculpture and pottery.

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 as mathematical tools, data and humans come together.

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.

This workshop has been well received by attendees at OR65 (the conference of the Operational Research Society UK) was run at Analytics Summit 2024 and is now back for OR66 by popular demand!

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Exploring Operations Research with R

Prof Jim Duggan

University Of Galway

Making an Impact - Exploring Operations Research with R, LR1, September 11, 2024, 11:00 - 12:30

Biography:

Jim Duggan is a personal professor in computer science at the University of Galway, Ireland. He lectures on R, MATLAB[®], and system dynamics, and he is a certified RStudio tidyverse instructor. His research interests are interdisciplinary and focus on the use of simulation and computational methods to support public health policy. You can learn more about his work on R and computation modelling on his GitHub site <https://github.com/JimDuggan>.

This workshop will demonstrate how R can be integrated with operations research. It will present a summary of R's tidyverse, and key tools such as ggplot2, dplyr and purrr, and show how they can be used to process a range of datasets. It will then show examples of using R to support several operations research methods, including: exploratory data analysis, linear programming, agent based simulation, and system dynamics. The workshop format will be interactive, and participants will be able to run the code examples using their account on Posit Cloud (which should be setup in advance of the workshop).

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Measuring Impact in the Third Sector

Evelyn Hardy

Measuring Impact in the Third Sector, LR5, September 11, 2024, 11:00 - 12:20

This panel session will explore the critical role of impact measurement, monitoring, and evaluation for charities and other third sector organisations in delivering impactful results and navigating today's challenges. As these organisations strive to do more with less and demonstrate their value to potential funders, many are feeling the pressure. We will discuss where Operational Research can make the biggest difference. Should we focus on aligning outcomes with strategic objectives, or is data capture and analysis the area where we can most usefully offer support?

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Exploring the perception and practice of integrating qualitative and quantitative methods in OR interventions.

Dr Eleanor Reynolds

Warwick Business School

Making an Impact - Integrating Qualitative and Quantitative Practice, LR3, September 11, 2024, 11:00 - 12:30

Biography:

Eleanor Reynolds is a Teaching Fellow in the Information Systems, Management and Analytics Group at Warwick Business School, where her teaching focuses upon problem structuring and strategy development.

Eleanor's PhD studies at Warwick Business School explored problem structuring (PS) in an everyday workplace, and her progress and findings have been presented at various national and international OR conferences. Eleanor also holds an MSc in Business Analytics and Consulting and a BSc in Management Science.

Prior to her research, Eleanor spent 12 years working in the water industry, during which time she was involved in structuring many problematic situations. Spanning analytics, project management and strategy development, her work has consistently focused upon the collaborative negotiation of change agendas. Highlights have included partnership working within Defra's catchment-based approach to improving UK watercourses and leading Severn Trent Water's operational Scenario Planning and wastewater strategy development process.

Historically, OR emerged as an interdisciplinary practice, sharing knowledge and methods, and integrating quantitative and qualitative approaches to develop new operational practices. Whilst today's practitioners continue to work with interdisciplinary teams, relatively little emphasis is placed upon the integration of qualitative and quantitative work that takes place. Exploring contemporary perception and practice, this session will involve small group discussion of how qualitative and quantitative analyses are developed and used, and how their integration contributes to the progress of OR interventions. Participants may expect this to be a reflective space, prompting insightful conversation concerning how OR projects develop and evolve, sharing challenges and obstacles experienced and overcome, and considering the range of competencies relevant to OR practice.

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Building the Relevance of OR, and the OR Society, the Future

Mrs Sarah Davies

The Operational Research Society

Making an Impact - Building the Relevance of OR, and the OR Society, the Future, LR4, September 11, 2024, 11:00 - 12:30

Biography:

Head of Membership Engagement for The Operational Research Society

In a rapidly evolving world where data-driven decision-making is more critical than ever, Operational Research (OR) stands at the crossroads of opportunity and transformation. As we navigate the challenges of the future, how can the OR Society position itself as the leading force in innovation, relevance, and global impact?

As the Operational Research (OR) Society looks to the future, a strong and dynamic brand is essential to reflect its evolving mission and the growing impact of OR in today's world. Join us for an inspiring 90-minute workshop dedicated to reviewing and refining design concepts that will shape the future identity of the OR Society.

This interactive session will provide participants with a first look at potential brand designs, each crafted to capture the essence of the OR Society's values, vision, and the transformative power of operational research. We will explore how these concepts align with the Society's goals and how they can help increase visibility, engagement, and relevance within both the OR community and broader audiences.

Key workshop activities include:

- Reviewing a range of design concepts, including logos, colour schemes, and visual themes.
- Discussing how each design reflects the OR Society's mission and future aspirations.
- Gathering feedback and insights from participants to refine and enhance the proposed designs.
- Identifying the elements that will resonate most with members, partners, and stakeholders.

Your participation is crucial in ensuring that the OR Society's brand not only stands out but also inspires and connects with its diverse audience.

Whether you are a member, a design enthusiast, or simply passionate about the future of OR, this workshop is your opportunity to contribute to the Society's brand evolution.

Be part of the creative process that will define the future identity of the OR Society. Your voice and vision can help shape a brand that truly represents the innovative and impactful nature of operational research.

Don't miss this chance to be part of the conversation that will define the future brand of the OR Society.

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The future OR Toolkit

Dr Frances O'Brien

Making an impact - What should be in the Future OR Toolkit?, LR4, September 11, 2024, 13:30 - 15:00

The OR Society website has an area that outlines the collection of 'OR Methods' (<https://www.theorsociety.com/about-or/or-methods/>) which forms the public face of OR that we, as the UK Society, claim to constitute the classic OR toolkit. UK OR has historically promoted a much broader representation of OR compared to other international OR professional bodies, for example incorporating both quantitative and qualitative approaches. The workshop will be organised into two blocks. Firstly we will review this current collection and identify any aspects (methods, methodologies, techniques, tools) that are missing and which should be represented within the collection. Second, we will discuss what should constitute the collection of methods and methodologies going forward particularly given recent developments in areas such as AI and GenAI.

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Systems Thinking for Strategic and Operational Improvement using ProOH Modelling

Professor Ben Clegg¹, Dr Krishna Balthu¹

¹Aston University, Aston Business School

Making an Impact - Systems Thinking using ProOH modelling, LR3, September 11, 2024, 13:30 - 15:00

Biography:

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 is a Lecturer in Operations Management and Systems Thinking at Aston Business School. He has 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 the International Journal of Operations and Production Management among others. His work in the field of legal service innovation was recognised through awards, magazine articles, and invited talks at various fora 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. 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 (ProOH) 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 ProOH Modelling, in Action Research contexts, engages with the problem situation / system under observation and delivers practical changes. ProOH Modelling is for strategic operations management improvements but can also provide new insights to systemic thinking. See prohmodeller.org

Using examples from both manufacturing and service organisations, this workshop will explain how ProOH Modelling has facilitated change journeys of organisations using 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 allows delegates to learn the principles of the ProOH 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 want to lead impactful transformational change programmes in their organisations as ProOH 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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Simulation powered digital twins: a hands-on tutorial on integrating live data in simulations and maintaining them for operational decision-making

Christoph Werner

Simul8 Corporation

Making an Impact - Simulation Powered Digital Twins, LR1, September 11, 2024, 13:30 - 15:00

Biography:

Christoph Werner is a senior simulation consultant at Simul8. He has been working as part of Simul8's Simulation Excellence team since 2018 where he has delivered numerous simulation projects in various industries, ranging from the automotive, defence, food/beverage and energy industries to healthcare and other service sectors. He has an MSc and PhD in Operational Research and is interested in the research area of simulation modelling and, in particular, common modelling challenges around uncertainty quantification, such as scarce data.

Although digital twins have sparked enormous interest and promise in many industries and service sectors, such as manufacturing and healthcare, the market is often dissatisfied with merely mirroring the current state of a system. Instead, many companies and organisations are turning to simulation powered digital twins with the aim of understanding how to adapt and improve any predicted poor performance that their digital twin is forecasting. At Simul8, we often note this in the discussions with our users that want to integrate live data into their simulation models.

In this session we dive into the differences between digital twins and simulations while we also address the main aspects of simulation projects that incorporate live data. Learn from our experiences of delivering these in practice, what it takes to build simulation powered digital twins together with suitable prediction models, and more importantly what is required to maintain them. Especially the latter is a new challenge for us as OR professionals and we want to highlight what we can learn from software developers as we move our work beyond just being an analysis project but delivering a data product that will be used again and again while an organization relies on it for frequent operational decisions. We will reflect on some practical experiences within

different industries and sectors in this context to further highlight the importance of maintaining simulation powered digital twins.

As in previous years, we want to encourage a good discussion with anyone interested in digital twins and simulation. Further, this tutorial will showcase examples of how to achieve the above directly in Simul8 with the added benefit of providing participants with hands-on experience.

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Using Generative AI in OR Practice

Mr Balagopal Madhusoodhanan, Mr John Medhurst¹

1Larrainzar Consulting Solutions Ltd

Making an Impact - AI in Practice, LR2, September 11, 2024, 13:30 - 15:00

Biography:

Balagopal (Bala) Madhusoodhanan is currently serving as the Principal Architect of Intelligent Automation for a luxury brand headquartered in London. His role involves the design and development of Intelligent Automation solutions, encompassing areas such as Low Code, Robotic Process Automation (RPA), Chatbots, and Artificial Intelligence (AI).

Bala spearheads a global network of Intelligent Automation professionals, fostering an environment of innovation and collaboration. His expertise lies in retail technology and process transformation, backed by a rich professional history in these domains.

Previously, Bala held the position of Principal Architect for Intelligent Automation, Innovation & Supply Chain at a globally recognized Fortune 100 retail corporation. He possesses an in-depth understanding of the Microsoft Power Platform and holds the distinction of being a member of Microsoft's Customer Advisory Board.

The introduction of new Generative AI tools such as ChatGPT, Llama and Gemini gives the OR practitioner new opportunities and access to the ability to rapidly generate text, images and code.

This workshop will provide a forum for OR practitioners and any interested academics to discuss how they are using these tools, what value they add to the OR process and what pitfalls there might be to using these tools effectively.

The session will be introduced with a short presentation and will take the form of a moderated open discussion session.

The output of this workshop will be used to help inform the policy of the OR Society towards the use of Generative AI in OR and will contribute to initiatives such as the Validate AI workshops.

Metaheuristics

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A metaheuristic to optimise the knot location of splines in regression

Dr Ferran Espuny Pujol

Clinical Operational Research Unit, University College London

Parallel 2 - Metaheuristics, G1 Main Arts, September 10, 2024, 13:00 - 14:00

Biography:

Ferran is a Senior Research Fellow at the UCL Clinical Operational Research Unit (CORU). Ferran has a PhD in Mathematics and a MSc in Statistics and Operational Research. He did his PhD (in Spain) and three years of post-doctoral research (in Sweden and France) in Geometry and Statistics applied to Computer Vision.

Since May 2013, Ferran is doing research in health and social care, having co-authored 16 articles* in peer reviewed international journals and 2 written evidence reports. As part of this research, he develops and/or adapts methods and heuristics for (large) data processing, linkage, visualization, and analysis.

Ferran has been member of the Operational Research (OR) Society since 2023.

* Number of articles was reported in May 2024.

Splines can be used for the flexible estimation of a function, i.e. a spline is used to model the response in regression. Splines are also used to approximate the distribution of covariates in regression models. So we can really find splines as part of any regression method (GAM, logit, Cox, etc).

Usually the spline knots are placed equidistant and the spline degree is fixed, with at best a choice over the number of equidistant knots being made. The Matlab help page "How to choose knots" (<https://www.mathworks.com/help/curvefit/how-to-choose-knots.html>) provides an example using the Titanium heat data (De Boor programs and data are used by Matlab). The optimisation of knots based on derivatives (optknt routine) fails due to high changes in these; as workaround, a B-spline with equidistant knots is used as initial value for a local optimisation of the knot locations (newknt routine).

The optimisation of the position of spline knots is a non-convex problem, even for a given number of knots and fixed spline degree. Current gradient or stochastic optimisation methods get trapped in local minima and/or only work for few knots and small datasets. In contrast, other recent

methods based on combining derivatives of different order, require large samples to estimate such derivatives.

I propose an heuristic to optimise the spline degree, and the number and location of spline knots. For a given number of knots and degree of spline (quadratic or cubic), a local optimisation method is run (in parallel) for a sufficiently large number (at least 40) of randomly selected initial values, which include an equidistant sequence of knots. The optimal configuration of spline degree, knot number and knot location is selected using the Akaike information criterion (AIC) with a correction for small sample size (AICc).

The method was implemented using R software with a simple parallel implementation allowing to test simultaneously multiple initial values for the knot locations. I will exemplify the utility of this heuristic using real samples of different sizes. In simulations with up to 10 knots, the proposed method outperforms the classical approach using a fixed degree and knot number with equidistant knots.

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A NEW WAY OF SETTING HYPERPARAMETERS

JOHN WOODWARD

LOUGHBOROUGH UNIVERSITY

Parallel 2 - Metaheuristics, G1 Main Arts, September 10, 2024, 13:00 - 14:00

Biography:

John R. Woodward received a B.Sc. degree in theoretical physics, M.S. degree in cognitive science, and Ph.D. degree in artificial intelligence from the University of Birmingham, Birmingham, U.K. He is currently head of Computer Science at Loughborough University. He previously led the Operational Research group at Queen Mary, University of London (<http://or.qmul.ac.uk/people.html>) and prior to that lectured at the Universities of Stirling, Nottingham and Birmingham. He was with the European Organization for Nuclear Research (CERN), Switzerland, where he conducted research into particle physics, the Royal Air Force as an Environmental Noise Scientist, and Electronic Data Systems as a Systems Engineer.

Machine learning and optimization have progressed rapidly, in terms of performance and diverse applications. In parallel the hyperparameters that need to be set for these algorithms to perform well has grown. Critically, near optimum hyperparameters settings depend upon the algorithm and the dataset/optimization problem along with operational constraints e.g. execution time, memory, and hardware.

The community has progressed from manual tuning, which is subject to unconscious bias and is highly subjective, towards automated methods such as a grid search and a host of automatic parameter tuning tools e.g. Sequential Model-Based Optimization for General Algorithm Configuration (SMAC) and Iterated Racing for Automatic Algorithm Configuration (iRace). These

more systematic approaches enable us to compare algorithms more fairly but also identify better hyperparameters settings automatically. Many of the systems mentioned above use either a statistical approach or build a model of the optimization problem during runtime. Here we take a different approach.

We build a model mapping information about the data set and a machine learning algorithm to a set of hyperparameters. We take a set of data sets and to build our model. For each data set we identify a near optimal set of hyperparameters. For each data set we define a set of meta-features which describe a generic data set (i.e. not the features of a data set).

This approach therefore replicates what a human expert has been attempting to do in the past i.e. Given their experience (the model in our case) and the description of the dataset (i.e. A set of generic features about datasets), we can then generate a reasonably good set of parameters for this algorithm on this data set. Initial results, tested on synthetic and real world datasets, are promising.

We model this with a random forests and the algorithm we're targeting is this is trees.

Optimisation Under Uncertainty

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A Fast Ecological Inference Algorithm in the R×C case

Pablo Ubilla Pavez, Charles Thraves

University of Chile

Parallel 7 - Optimisation Under Uncertainty, G1 Main Arts, September 12, 2024, 09:00 - 10:30

Biography:

Pablo Ubilla is an Industrial Engineer with an MSc in Operations Management from Universidad de Chile. He is currently pursuing an MSc in Ecology and Data Science at UCL, focusing on the interdisciplinary applications of probability models and machine learning. His projects span political elections and quantitative ecology.

It is known the difficulty to address the R×C ecological inference problem. In the past, researchers have approached this problem from various angles, including parametric probability models, entropy- maximization, and mathematical programming. In this work, the ecological inference problem is based in an election context where at each ballot box we observe candidates' votes and the number of voters from each demographic groups. Employing a non-parametric model, we use the EM algorithm to maximize the likelihood given the observed data. We show that the M-Step can be solved in a closed-form solution, while the E-Step requires an exponential number of steps to be solved exactly. To address this, we evaluate several approximation methods to compute the E-Step in polynomial time. Through simulated instances, we observe that the resulting estimations of probabilities using these methods are very close to the real values.

Furthermore, some of these methods exhibit running times of less than a thousandth of a second. Then, we introduce a methodology to perform group aggregation in cases where there are insufficient samples, i.e., ballot boxes in this case, to accurately estimate voting probabilities. We apply this technique to the Chilean Presidential election of 2021, obtaining estimates of voting probabilities with bounded errors for each resulting group aggregation within each district. We note that, in general, the number of aggregated groups obtained increases with the number of ballot boxes. Finally, we show how these methods can also be used to detect outlier ballot boxes.

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Martingale Schrödinger Bridge For Newsvendors

Puru Gupta

University Of Warwick

Parallel 7 - Optimisation Under Uncertainty, G1 Main Arts, September 12, 2024, 09:00 - 10:30

Biography:

PhD Candidate interested in Operations Research, Quantitative Finance.

We consider the classical single commodity newsvendor problem in a stochastic setup where the commodity price distribution satisfies martingale and marginal constraints derived from no-arbitrage arguments. We show that there is strong duality between optimization problem of the newsvendor and the canonical martingale Schrödinger bridge (1932, E. Schrödinger, Annales de l'Institut Henri Poincaré) - the entropy minimizing martingale coupling amongst all equivalent martingale couplings of marginal distributions of the spot price at the procurement and retail dates. We obtain primal as well as dual attainment results under mild restrictions on the physical probability measure and characterize the optimal inventory policy of the buyer in terms of its dual martingale Schrödinger bridge.

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Simheuristics for Reducing Air Traffic Delays at Heathrow Airport

Dr Rob Shone¹, Dr Jamie Fairbrother²

¹Lancaster University, ²Lancaster University

Parallel 7 - Optimisation Under Uncertainty, G1 Main Arts, September 12, 2024, 09:00 - 10:30

Biography:

Rob Shone is currently a lecturer in Operational Research at Lancaster University.

Imbalances between demand and capacity at the world's busiest airports cause air traffic delays, which can have serious financial and environmental consequences. The capacity of the runway system generally acts as the main bottleneck at congested airports. To alleviate the burden on runway capacity, various types of interventions are possible. At the pre-tactical stage (from a few days up to a few hours before a day of operations), the schedule can be adjusted by imposing ground delays on flights in order to avoid "hotspots" of delay occurring at peak times. At the tactical stage (during the day of operations itself), sequencing of take-offs and landings can be optimised in order to minimise average time separations between runway movements, which depend on aircraft weight classes. Academic researchers have developed various mathematical models for optimising these kinds of interventions, but few of the developed models consider both pre-tactical and tactical interventions within an integrated model.

This talk will discuss the progress of an EPSRC-funded project, STIRAD, aimed at integrating pre-tactical and tactical interventions in order to reduce air traffic delays at Heathrow Airport. We formulate a stochastic dynamic optimisation problem in which the "system state" at any given time includes hundreds of variables evolving via continuous-time stochastic processes. Solution approaches via approximate dynamic programming are possible in theory, but very difficult to implement in practice. Instead we consider an approach based on the emerging field of "simheuristics", which involves continuously simulating possible trajectories of future random events and using a ranking and selection method to optimise runway sequences. In addition to this, hotspots of delay are identified and ground delays are imposed at regular intervals during the

day in order to smooth out the pattern of demand over the course of the day. This work is in collaboration with NATS (<https://www.nats.aero/>), which provides air traffic control services to airports in the UK and around the world.

Project & Risk Management

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Capturing Fintech's Role in Optimising Financial Risk Management

Dr. Odai Aljaloudi¹, Dr. Mouhamed Thiam², Prof. Tamer Darwish³, Dr. Muath Abdel Qader⁴, Dr M.K.S. Al-Mhdawi⁵, Dr. Abroon Qazi⁶, Dr Nicholas Dacre⁷

¹University of Gloucestershire, ²Nottingham Trent University, ³University of Gloucestershire, ⁴University of Gloucestershire, ⁵Teesside University, ⁶American University of Sharjah, ⁷University of Southampton

Parallel 1 - Project & Risk Management, LR4, September 10, 2024, 10:30 - 12:00

Biography:

Odai Aljaloudi is a Ph.D. candidate at Gloucestershire Business School, University of Gloucestershire. He holds an MSc degree in Accounting and Finance from Anglia Ruskin University. His current research interests include financial risks management and Fintech.

As Financial Technology (Fintech) continues to evolve rapidly, financial institutions recognise the need to integrate innovative solutions to enhance their risk management strategies. This acknowledgment stems from the potential benefits that Fintech offers in mitigating financial risks. However, despite this growing recognition, empirical research, particularly in emerging markets such as Jordan, remains scarce. To this end, this study aims to evaluate how Fintech applications impact the enhancement of financial risk management practices in Jordan. A questionnaire survey was developed and administered to 11 financial risk experts in Jordan to assess the effects of Fintech adoption on financial risk management. Participants evaluated the potential of Fintech applications, such as digital lending and credit, mobile banking, mobile payments, cryptocurrency, blockchain, and online trading, to improve financial risk management practices. The study findings indicate a perceived positive impact of Fintech adoption on enhancing the efficacy of financial risk management practices in Jordan. This study significantly contributes to the literature by shedding light on the positive impact of Fintech adoption on financial risk management, particularly in emerging markets like Jordan. Moreover, this study has important implications for policymakers, regulators, and banking practitioners, highlighting the importance of creating an enabling environment for Fintech adoption to address financial risks proactively.

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Exploring Opportunities, Challenges, and Risks of Generative AI in Construction Risk Management

Mr Mohamed Mohamed¹, Dr M.K.S. Al-Mhdawi², Dr. Abroon Qazi³, Dr Farzad Rahimian⁴, Dr Nicholas Dacre⁵

1Teesside University, 2Teesside University, 3American University of Sharjah, 4Teesside University,
5University of Southampton

Parallel 1 - Project & Risk Management, LR4, September 10, 2024, 10:30 - 12:00

Biography:

Mohamed Mohamed is a dedicated and passionate PhD student at Teesside University's School of Computing, Engineering & Digital Technologies. With a profound interest in project management and technological advancements, Mohamed's academic journey has been marked by a pursuit of excellence and a commitment to innovative research. He holds a Master's degree in Project Management from Teesside University, where he honed his skills in strategic planning, risk management, and project delivery. During his master's studies, Mohamed demonstrated exceptional academic prowess and a keen ability to apply theoretical concepts to real-world scenarios.

Mohamed's current research is centered on implementing AI in risk management, particularly in the construction field. He is investigating the opportunities, challenges, and risks associated with generative AI in Construction Risk Management (CRM). Mohamed's work aims to develop a framework guiding the integration of AI into CRM and enhancing its performance. By focusing on AI applications, he seeks to provide valuable insights into how AI can revolutionize risk management practices in construction, thereby improving project outcomes and organizational effectiveness.

The purpose of this research is to explore the opportunities, challenges, and risks of implementing Generative Artificial Intelligence (GenAI) in Construction Risk Management (CRM). A three-step systematic literature review methodology was employed to analyse 55 selected articles on GenAI in CRM from well-regarded and relevant academic journals published from 2014 to 2024. The systematic review of prior work has yielded 94 opportunities, challenges, and risks of GenAI implementations in CRM. The top three opportunities of implementing GenAI in CRM include enhanced risk identification, improved risk prediction, and enhanced decision-making processes. Additionally, the three significant challenges of GenAI implementation are framing data governance, managing initial high costs, and establishing trust between AI systems and stakeholders. Finally, the top three risks identified are inaccurate data quality, data unavailability, and legal implications of data breaches. This research provides valuable insights for stakeholders at all levels, from project managers to policymakers, in navigating the complex landscape of GenAI integration in construction management. With the opportunities highlighted, companies can utilise GenAI technologies to make more informed and faster decisions, thereby gaining a competitive edge. Furthermore, it highlights the importance of ongoing research and dialogue within the industry to refine GenAI applications and effectively address evolving challenges and risks in CRM.

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Examining the Integration of Generative AI Models for Improved Risk Management Practices in the Financial Sector

Dr. Odai Aljaloudi¹, Dr. Mouhamed Thiam², Dr. Muath Abdel Qader³, Dr M.K.S. Al-Mhdawi⁴, Dr. Abroon Qazi⁵, Dr Nicholas Dacre⁶

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Parallel 1 - Project & Risk Management, LR4, September 10, 2024, 10:30 - 12:00

Biography:

Odai Aljaloudi is a Ph.D. candidate at Gloucestershire Business School, University of Gloucestershire. He holds an MSc degree in Accounting and Finance from Anglia Ruskin University. His current research interests include financial risks management and Fintech.

The rapidly evolving landscape of the financial sector demands continuous innovation in risk management practices to ensure stability and sustainability. With the emergence of Generative Artificial Intelligence (GenAI) models like ChatGPT, there's a pivotal opportunity to revolutionise traditional risk management practices. These models possess the capability to analyse vast datasets rapidly, identify emerging risks, and offer predictive insights that surpass human capabilities alone. However, understanding the practical implications and challenges of integrating GenAI into risk management processes is essential for maximising its benefits. Accordingly, this study aims to investigate how GenAI can be effectively employed across different stages of the risk management process, i.e., planning, identification, analysis, response, and monitoring and control, in the financial sector. We distributed an open-ended survey to 10 financial risk experts in Jordan to collect their insights on the key benefits and challenges of using GenAI models, such as ChatGPT, for risk management in the financial sector. The study findings revealed that GenAI models exhibit significant potential in aiding risk management efforts at each stage. In addition, the findings showed that these models facilitate more accurate risk identification by capturing complex patterns in financial data, leading to improved analysis and decision-making, while also supporting timely responses to emerging risks and enhancing ongoing monitoring and control mechanisms. This research offers insights into the practical application of GenAI models in risk management, providing actionable guidance for financial institutions in Jordan and beyond. Furthermore, it highlights the importance of continued exploration and adoption of innovative AI technologies to strengthen risk management practices and ensure the resilience of the financial sector in the face of evolving challenges.

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Examining the Impact of Credit Risk Management Challenges on Bank Performance: The Mediating Role of Best Practices.

Dr. Odai Aljaloudi¹, Dr. Mouhamed Thiam², Dr. Muath Abdel Qader³, Dr M.K.S. Al-Mhdawi⁴, Dr. Abroon Qazi⁵, Dr Nicholas Dacre⁶

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Parallel 2 - Project & Risk Management, LR4, September 10, 2024, 13:00 - 14:00

Biography:

Odai Aljaloudi is a Ph.D. candidate at Gloucestershire Business School, University of Gloucestershire. He holds an MSc degree in Accounting and Finance from Anglia Ruskin University. His current research interests include financial risks management and Fintech.

In the dynamic landscape of banking, effective credit risk management is crucial for maintaining financial stability and performance. Commercial banks are confronted with numerous challenges in managing credit risk, which can significantly impact their overall performance. Understanding the relationship between credit risk challenges and bank performance, as well as the mediating role of best practices, is essential for navigating the complexities of modern banking systems—a comprehension that was overlooked by prior financial risk management literature. To this end, this study aims to investigate the impact of credit risk challenges on bank performance and the mediating role of credit risk management best practices. To achieve this, a mixed-method research approach was employed. Firstly, semi-structured interviews were conducted with 9 credit risk experts in Jordan to identify key credit risk management challenges and credit risk management best practices. Secondly, Partial Least Squares-Structural Equation Modelling (PLS-SEM) was employed to analyse the direct and indirect effects of credit risk management challenges on bank performance. The results of the SEM analysis show that economics –related challenges, operational –related challenges, regulatory compliance –related challenges, and technological –related challenges have a significant impact on banks performance. The results also emphasis the significant mediation role of credit risk management best practices between credit risk management challenges and banks performance. This research contributes to the existing body of knowledge by providing a comprehensive understanding of the dynamics between credit risk management challenges, credit risk management best practices, and bank performance. Furthermore, the findings offer actionable insights for banking practitioners, regulators, and policymakers, enabling them to develop more effective credit risk management practices and enhance the stability and sustainability of the banking sector in Jordan.

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Investigating the Nexus Between Credit Risk Management Challenges and Banks Performance: Perspectives from Commercial Banks in Emerging Markets

Dr. Odai Aljaloudi¹, Dr. Mouhamed Thiam², Prof. Tamer Darwish³, Dr. Muath Abdel Qader⁴, Dr M.K.S. Al-Mhdawi⁵, Dr Nicholas Dacre⁶

1University of Gloucestershire, 2Nottingham Trent University, 3University of Gloucestershire, 4University of Gloucestershire, 5Teesside University, 6University of Southampton
Parallel 2 - Project & Risk Management, LR4, September 10, 2024, 13:00 - 14:00

Biography:

Odai Aljaloudi is a Ph.D. candidate at Gloucestershire Business School, University of Gloucestershire. He holds an MSc degree in Accounting and Finance from Anglia Ruskin University. His current research interests include financial risks management and Fintech.

With the increasing complexity of global financial markets, commercial banks in emerging markets face a myriad of challenges in managing credit risk, which directly impacts their performance. While the importance of credit risk management is widely recognised, there is a lack of comprehensive research on the nexus between credit risk challenges and banks' performance, particularly in emerging markets. Existing literature on credit risk management often focuses on developed markets, neglecting the unique challenges faced by banks in emerging markets. There is a pressing need for empirical studies that explore the specific credit risk challenges encountered by commercial banks in emerging markets and their implications for banks' performance. To this end, this study aims to fill this gap by investigating the relationship between credit risk management challenges and banks' performance in emerging markets by considering the case of Jordan. Specifically, the study seeks to identify and assess the significance of key credit risk challenges faced by commercial banks and their impact on various performance indicators. A mixed-methods research approach was adopted, comprising a systematic literature review to identify the credit risk management challenges and a questionnaire survey to credit risk professionals in Jordan to rank the significance level of the identified challenges. This study identified 21 credit risk management challenges, which were classified into four categories: operational, economic, technological, and regulatory compliance. Furthermore, the analysis results indicated that the top five significant challenges across all categories were escalating cybersecurity threats, fluctuations in interest rates, inadequate resources and expertise, changes in regulatory frameworks, and the lack of system integration within the banks departments. This research contributes to a deeper understanding of the credit risk management landscape in emerging markets and provides valuable insights for policymakers, regulators, and banking practitioners. By addressing the identified challenges, commercial banks can enhance their credit risk management practices, improve performance, and ultimately contribute to the stability and resilience of the financial system in emerging markets.

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Investigating the Influence of Industry 5.0 on Supply Chain Integration and Performance: An Empirical Study in the Manufacturing Industry

Ms Jingyang Yan¹, Dr Nicholas Dacre¹, Dr Hao Dong¹, Dr M.K.S. Al-Mhdawi², Dr Regina Frei³

¹University Of Southampton, ²Teesside University, ³University Of Surrey

Parallel 3 - Project & Risk management, LR4, September 10, 2024, 14:10 - 15:10

Biography:

Jingyang Yan is a PhD candidate at Southampton Business School, University of Southampton. She holds an MSc degree in Supply Chain Management and Logistics from University of Southampton.

Her current research interests include Industry 5.0, sustainable supply chain, sustainability, and multi-criteria decision-making (MCDM).

Industry 5.0 (I5.0) is increasingly emerging as a prominent paradigm within the global business landscape. This shift introduces a notable change in multiple aspects, considering its three core values: human-centricity, sustainability, and resilience. As a result, academics and practitioners may need to re-examine the concept of supply chain management, particularly within the manufacturing industry. Whilst previous research has identified the potential of I5.0 to enhance supply chain performance (SCP), there has been insufficient attention paid to understanding the nature and implications of human-AI interactions. Specifically, there is a lack of adequate discussion on how I5.0 can improve SCP. This exploratory study therefore aims to develop theoretical insights and empirically examine the relationships between I5.0 and SCP in the manufacturing industry, with a mediating role of supply chain integration (SCI). Adopting a dynamic capabilities perspective, we argue that overcoming the challenges associated with implementing I5.0 may motivate companies to integrate their supply chains and enhance their SCP. Structural Equation Modelling (SEM) is applied to test the hypotheses using survey data from 230 industry professionals, followed by a fuzzy analytic hierarchy process (FAHP) to quantify and prioritise the impacts of I5.0 challenges on SCP indicators. The results indicate that I5.0 has a direct positive impact on both SCI and SCP. Furthermore, the mediation analysis suggest that SCI plays a significant role in mediating the relationship between I5.0 and SCP. These findings offer valuable managerial implications, providing decision-makers and practitioners with insights into the potential benefits of implementing I5.0 practices and the salience of fostering supply chain integration to enhance performance in the context of this new paradigm. This research contributes to the body of knowledge by empirically validating the relationships between I5.0, SCI, and SCP in a single model, thereby addressing the gap in the literature between these distinct research streams. Our findings provide a foundation for future research in supply chain management. To further extend the generalisability of our results, future studies could replicate this research in other industries and across different economic contexts, enabling a more comprehensive examination of the impact of I5.0 on supply chain performance.

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Methodological Review of Risk Identification and Analysis in Oil and Gas Construction Projects

Dr M.K.S. Al-Mhdawi¹, Ali Mudassar Ali², Dr. Abroon Qazi³, Dr Abdelkader Daghfous⁴, Mr Mohamed Mohamed⁵

¹Teesside University, ²American University of Sharjah, ³American University of Sharjah, ⁴American University of Sharjah, ⁵Teesside University

Parallel 3 - Project & Risk management, LR4, September 10, 2024, 14:10 - 15:10

Biography:

M.K.S. Al-Mhdawi is a lecturer in Engineering Project Management at the School of Computing, Engineering, and Digital Technologies at Teesside University, UK, and a researcher in Safety Engineering at Trinity College Dublin, Ireland. He earned his PhD in Risk Management from the University of Southampton, UK, and has over 12 years of experience in integrating risk and safety management within core business processes across various industries such as construction, manufacturing, mining, oil and gas, finance, space, and healthcare systems.

Oil and Gas Construction Projects (O&GCPs) are complex and risky due to their dynamic environments, unique characteristics, advanced technologies, remote geographical locations, and the involvement of numerous stakeholders, necessitating adherence to tight schedules and budgets. There are numerous risks associated with O&GCPs, including social, political, financial, and technical risks, as well as those associated with natural disasters. Understanding the risks associated with the energy sector is vital not only for the construction sector but also for the upstream and downstream oil and gas sub-sectors. Despite the critical importance of risk management in O&GCPs, existing research has primarily focused on risk assessment, with insufficient attention paid to exploring the methods for risk identification, classification, analysis, and quantification. To bridge this gap, this research aims to determine the key methods used for risk identification, classify risks based on their sources, and identify the primary techniques employed in O&GCP literature for risk analysis and quantification. To achieve this, a three-step systematic literature review approach was adopted, including search engine and journal selection, keyword identification and article selection, and manual content analysis. The findings of this research offer valuable insights for governments and contracting companies by highlighting the key methods for risk identification and analysis in O&GCPs, applicable across various geographical regions. These insights are instrumental for construction practitioners, enabling them to develop effective risk response strategies during the early phases of a project. Moreover, this research provides a comprehensive list of publications from reputable academic journals, serving as a valuable resource for academics interested in conducting future research on O&GCPs.

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Unveiling Project Managers' Heuristics: Enforcing De-Escalation of Commitment during AI-enhanced Project Decision Support Systems

Mr Fredrik Kockum¹, Martin Kunc, Dr Nicholas Dacre

¹University Of Southampton

Parallel 7 - Project & Risk Management, LR5, September 12, 2024, 09:00 - 10:30

Biography:

The author team consists of deep project management expertise and Operational Research knowledge. One of the authors from University of Southampton will present the paper at the conference.

Substantial opportunities exist for project managers to leverage Artificial Intelligence (AI) based Decision Support Systems (DSS) for enhanced analytics. Project professionals often face complex decision-making challenges during the control phase of escalating projects. AI-powered DSSs improve decision processes and facilitate corrective actions. However, the pervasive bias of Escalation of Commitment often impedes the effective implementation of De-escalation strategies, restricting effective interventions. This study advances project management understanding by exploring managerial heuristics influenced by the newly identified 'wait effect' bias from AI DSS. Insights are conveyed using a Causal Loop Diagram model, highlighting feedback dynamics within project management.

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To what extent can unsupervised machine learning predict regions within a project social network that have a propensity for relationship conflict

Dr Richard Williams¹, Prof Michael Butler²

¹Lancaster University, ²Bangor University

Parallel 7 - Project & Risk Management, LR5, September 12, 2024, 09:00 - 10:30

Biography:

Dr Williams is a Senior Lecturer in the Department of Management Science, Lancaster University. He has expertise in both 'hard' and 'soft' Operational Research, and is a member of: the multidisciplinary Data Science Institute (DSI); the Centre for Technological Futures (CTF); and the Lancaster Intelligent, Robotic and Autonomous Systems Centre (LIRA).

Dr Williams' research revolves around the broad theme of Complex Systems Science to investigate real-world systems. At present, he has particular interests in two main areas around: Modelling and Simulation of Complex Organisational Systems, and Computational Intelligence as applied to Project Management as a Complex System.

Prior to becoming an academic, Dr Williams was an Applications Technology Consultant and then Project Manager at Oracle Corporation UK Ltd. Alongside his academic credentials in Biochemistry, Immunology and Computer Science, he is also a Chartered IT Professional, Chartered Engineer and Fellow of the British Computer Society (CITP CEng FBCS); a Senior Member of the Institute of Electrical and Electronics Engineers (SMIEEE); a Project Management Professional of the Project Management Institute (PMP); and a Fellow of the Royal Society for the Advancement of Arts, Manufactures and Commerce (FRSA).

There continues to be failures in the management of large information systems (IS) projects, particularly in the public sector where the majority incur significant cost and time overruns. The majority of these failures are not due to technology but instead due to human and organisational

reasons. IS projects at large organisations are usually implemented by third-party service providers, with the largest projects using the consultancy services of both the software vendor and professional service providers. Within these project environments, communication and trust becomes a critical factor for project success, which we believe to be an important reason for failure due to the complex dynamics that arise from work-place interactions between team members. As such, we believe that an important reason for project failure might be the behaviours that emerge through the social networks within large multi-partner IS project environments.

We have previously argued that conflict is inherent to the project-based approach for implementing large IS projects, and that once developed, can propagate along the social network of these environments. Within these project-based working environments, conflict can develop through frequent (or acute) differences in opinions/outlook and can also be characterised as incompatibilities between resources at the interpersonal level. Three main forms of conflict have been found within project teams, relating to Task, Process and Relationship Conflict. The most damaging is relationship conflict because it can propagate throughout the social network of the project team members. We conjecture that this propagation is similar to the way that a contagious illness/disease can infect people within a given community. Within this work, we use unsupervised machine learning techniques to identify regions in the social network that might have a propensity to initiate relationship conflict or to acquire this form of conflict once it has developed within the project team.

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Optimising Project Management Software Selection through Analytical Hierarchy Process

Mr Mohamed Mohamed¹, Dr M.K.S. Al-Mhdawi², Dr. Abroon Qazi³, Dr C. Mahammedi⁴, Dr Nicholas Dacre⁵

¹Teesside University, ²Teesside University, ³American University of Sharjah, ⁴Teesside University, ⁵University of Southampton

Parallel 7 - Project & Risk Management, LR5, September 12, 2024, 09:00 - 10:30

Biography:

Mohamed Mohamed is a dedicated and passionate PhD student at Teesside University's School of Computing, Engineering & Digital Technologies. With a profound interest in project management and technological advancements, Mohamed's academic journey has been marked by a pursuit of excellence and a commitment to innovative research. He

holds a Master's degree in Project Management from Teesside University, where he honed his skills in strategic planning, risk management, and project delivery. During his master's studies, Mohamed demonstrated exceptional academic prowess and a keen ability to apply theoretical concepts to real-world scenarios.

Mohamed's current research is centered on implementing AI in risk management, particularly in the construction field. He is investigating the opportunities, challenges, and risks associated with generative AI in Construction Risk Management (CRM). Mohamed's work aims to develop a framework guiding the integration of AI into CRM and enhancing its performance. By focusing on AI applications, he seeks to provide valuable insights into how AI can revolutionize risk management practices in construction, thereby improving project outcomes and organizational effectiveness.

In the field of Project Management (PM), the complex nature of projects necessitates the adoption of project management software as a fundamental practice for planning, executing, and controlling projects. However, selecting the appropriate project management software poses numerous challenges and difficulties. These challenges include varying software features that must align with specific project needs, scalability concerns, and varying levels of user expertise. To this end, this research seeks to develop a PM software selection model for the key domains of knowledge specified by the Project Management Institute (PMI) under the Analytical Hierarchy Process (AHP) environment. A two-phase research methodology was adopted for data collection, analysis, and processing. The first phase involved a systematic literature review to identify the key PM software for PMI domains of knowledge, their characteristics, and selection criteria. The second phase involved developing an AHP model to quantitatively determine the importance of each selection criterion. The findings of this research provide project managers, software procurement teams, and organisational decision-makers with a systematic approach to select the most suitable PM software for their specific needs. The developed model enables them to navigate the complexities of various software options and make informed decisions that align with their strategic goals and project demands.

Responsible OR and AI

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Exploring Ethical AI

Mr Balagopal Madhusoodhanan

Individual Member

Parallel 1 - Responsible OR and AI - WORKSHOP, LR3, September 10, 2024, 10:30 - 12:00

Biography:

Balagopal (Bala) Madhusoodhanan is currently serving as the Principal Architect of Intelligent Automation for a luxury brand headquartered in London. His role involves the design and development of Intelligent Automation solutions, encompassing areas such as Low Code, Robotic Process Automation (RPA), Chatbots, and Artificial Intelligence (AI).

Bala spearheads a global network of Intelligent Automation professionals, fostering an environment of innovation and collaboration. His expertise lies in retail technology and process transformation, backed by a rich professional history in these domains.

Previously, Bala held the position of Principal Architect for Intelligent Automation, Innovation & Supply Chain at a globally recognized Fortune 100 retail corporation. He possesses an in-depth understanding of the Microsoft Power Platform and holds the distinction of being a member of Microsoft's Customer Advisory Board.

Objective:

The objective of this workshop is to equip participants with a solid understanding of ethical AI, its importance, and how it can be practically implemented using the OECD principles. Through interactive sessions and practical exercises, participants will gain insights into the challenges and solutions in creating ethical AI systems.

Theoretical Foundations of Ethical AI (30 minutes): We will begin with an introduction to the concept of ethical AI, discussing its importance and the key principles that guide its implementation. This will include an overview of the OECD Principles on AI, which provide a global standard for responsible stewardship of trustworthy AI.

Interactive Game on Ethical AI (30 minutes): To make the learning process more engaging, we will conduct a game that illustrates the dilemmas and decisions involved in creating ethical AI systems. This interactive session will help participants understand the complexities and trade-offs in real-world scenarios.

Industry Case Study (30 minutes): We will present a case study from the industry where AI has been successfully implemented in alignment with the OECD principles. This will provide participants with a practical understanding of how ethical AI principles are applied in real-world situations.

Group Exercise: Building AI Principles with the OECD

Framework (30 minutes): In this session, participants will work in groups to understand the vision and value of the conference and build AI principles using the OECD framework. This exercise will allow participants to apply their learning in a practical context, fostering a deeper understanding of ethical AI.

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AI-Assisted Research in Government

Mr Aleksandar Vladimirov

Manchester Metropolitan University

Parallel 5 - Responsible OR and AI, The Kate Roberts (OSCRB), September 11, 2024, 11:00 - 12:30

Biography:

A Researcher, UX Designer and Chartered Scientist I work in both qualitative and quantitative research paradigms.

With experience of working in public, private and third sectors my passion is for the intersection of research and design, as applied to everyday problems.

I have a core academic interest in decision-making under uncertainty, specifically formalising intuitions into rules of thumb/heuristics. This lends itself well to fit with the Problem Structuring Methods streams in Operational Research while my practice is also informed by other methods. Research in government is often conducted under significant uncertainty. Sometimes to avoid this sense of uncertainty, an ever-increasing complexity of detailed administrative documentation takes over. This administrative burden can distract researchers from their primary goal of embedding an evidence-based culture in their work. To truly cultivate an evidence-based culture, the research process must be streamlined, allowing researchers to focus their creativity on reducing bias and noise (Kahneman, 2003; 2021) rather than busy work.

Emerging technologies like Artificial Intelligence (AI) offer a path forward. By leveraging AI-enabled assistance the administrative burden on researchers can be significantly reduced. The risk then is that we may lose control over the important decision steps in research design that should not be automated.

This project aims to develop an AI-powered research assistant that can enable researchers to balance the efficiency of AI tools with expert intuition (Klein, 2011). By automating many of the routine tasks, the assistant can free up researchers to dedicate more time and energy towards thinking longer about which research decisions are taking their work in a different direction.

The session will show a prototype in development for feedback.

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Enhancing EDI through the Integration of Large Language Models and AI

Dr Sara Saravi, Mr Haizoom Nawaz, Miss Isobel Bramwell, Mr Emmanuel Adio, Dr Firat Batmaz, Dr Parisa Derakhshan, Dr Yanning Yang, Dr Hossein Nevisi

Loughborough University

Parallel 5 - Responsible OR and AI, The Kate Roberts (OSCRB), September 11, 2024, 11:00 - 12:30

Biography:

Sara received her M.Sc. and Ph.D. from Computer Science Department, Loughborough University in Computer Vision and Machine Learning.

Sara has worked as KTP associate in ARM (formerly Apical), as a Research Associate in Loughborough University, where she continued working as a University Teacher until 2019. She was a lecturer in University of Derby before joining the Computer Science department of Loughborough University in 2021.

Sara is the AI in EDI Lead in the AI in Education (AIED) group. This group is committed to exploring and demonstrating the potential of artificial intelligence in enhancing educational practices. The group focuses on developing workshops, both within and outside the university, aimed at explicating the advancements in AI and their practical applications in education.

This paper investigates the pioneering integration of large language models (LLMs) and artificial intelligence (AI) avatars to enhance Equity, Diversity, and Inclusion (EDI) within educational settings. Implemented as a summer internship project, this initiative allowed university students to create AI-driven immersive learning environments aimed at exposing and addressing unconscious bias during job interviews. The core objectives were to cultivate empathy, critical thinking, and a deeper understanding of EDI challenges among participants, as well as to explore the application of new AI technology in the field of EDI, potentially leading to more inclusive academic and professional landscapes.

The approach combined cutting-edge LLMs, such as GPT-4, with prompt engineering techniques to simulate realistic job interview scenarios where unconscious biases could be visibly demonstrated and analysed. Through these simulations, participants engaged with AI-driven avatars that portrayed diverse interviewee profiles, providing a dynamic and interactive learning experience.

This methodology facilitated a practical understanding of unconscious biases and promoted hands-on interaction with advanced AI tools, thereby enhancing both technical and interpersonal skills among the students.

By incorporating feedback loops and iterative refinements based on initial testing phases, the project ensured the development of high-quality, realistic AI scenarios that effectively mimicked real-world biases. Prompt engineering played a critical role in tailoring the AI responses to create contextually relevant and impactful dialogues, further enhancing the authenticity of the interactions.

Findings from the project highlight a significant enhancement in participants' awareness and understanding of EDI issues, driven by their active engagement in the AI-driven scenarios. Feedback indicated that the immersive nature of the technology, coupled with the authenticity of the AI-generated dialogues, substantially increased the efficacy of the learning experience.

The project not only demonstrates the viability of integrating AI and LLMs in EDI training but also suggests a scalable model for future educational endeavours aiming to address such critical social issues. The successful implementation of such technologies can serve as a benchmark for similar initiatives, promoting a more inclusive and equitable environment across various professional fields.

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Responsible Use of AI in Assessment Feedback Generation

Dr Yanning Yang, Mr Alex Carver, Ms Charlotte Jones, Dr Firat Batmaz, Dr Hossein Nevisi, Dr Parisa Derakhshan, Dr Sara Saravi

Loughborough University

Parallel 5 - Responsible OR and AI, The Kate Roberts (OSCRB), September 11, 2024, 11:00 - 12:30

Biography:

Yanning Yang is a University Teacher in the Computer Science department, Loughborough University. She is a member of AI in Education (AIEd) group. Their research includes integrating AI into education, with projects like VR and chatbot-based unconscious bias training, AI-powered feedback for assessments, AI-generated multimedia for teaching, as well as developing guidance and training on the responsible use of AI. They have recently run a nation wide Validate AI workshop.

Advances in AI and large language models (LLMs) have led to growing interest in integrating AI across various sectors, including higher education, where AI is being leveraged to enhance students' learning experiences. However, there are concerns about the risks of using AI and the "trust" issues regarding the information AI provides. Our study focuses on an AI-powered Feedback Generation System that was developed to provide personalised assessment feedback to

university students, as an example case of how AI can be used responsibly to create positive impact.

The AI-powered feedback generation tool was designed to keep humans in the loop while utilising AI to improve the efficiency and effectiveness of creating feedback based on academic staff's judgment. Academics provide a marking breakdown spreadsheet and assessment data, which the system, powered by GPT-4 from OpenAI, analyses to produce customised individual reports for students. Additionally, the system generates cohort analysis, student analysis, comparisons between cohorts, and question analysis. In this way, human academic judgment is retained, and AI speeds up the feedback generation process.

The acceptance of the AI-powered Feedback Generation System was evaluated from the viewpoints of university students and academic staff. A recent survey of 48 student participants revealed that 84.5% found the reports beneficial in guiding their future learning, and 63% expressed interest in using the reports after formative assessments. Through two interactive workshops, a total of 10 staff participants from three different schools across the university evaluated the system. Anonymised training data was provided to the staff participants to interact with the system. Their feedback was collected through Q&A sessions and an online anonymous questionnaire. The results confirmed that the system provided a very useful feature set and time-saving capability for staff. It also revealed staff concerns about trust and highlighted the need to keep academic staff in the final validation process of the generated feedback to ensure that the feedback is accurate and appropriate before releasing it to students. In future work, we aim to improve the transparency and explainability of the feedback generation system.

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Co-Developing Causal Graphs with Domain Experts Guided by Weighted FDR-Adjusted p-values

Dr Eli Yechezkiel Kling

Avanade

Parallel 8 - Responsible OR and AI, LR4, September 12, 2024, 11:00 - 12:30

Biography:

PHD in applied statistics under Prof. Yoav Benjamini where the research focus was the application of the FDR paradigm to Statistical Process Control.

34 years of experience in delivering advanced analytics, machine learning and optimisation in consulting settings.

Currently working at Avanade.

Interests: Causality analyses, Applications of Quantum computing in industry, Responsible AI.

Committee Member of the RSS/BIS

This paper proposes an approach to facilitate co-design of causal graphs between subject matter experts and statistical modelers. Modern causal analysis starting with formulation of a causal graph provides benefits for robust analysis and well-grounded decision support. Moreover, this process can enrich the discovery and planning phase of data science projects.

The key premise is that plotting relevant statistical information on a causal graph structure can facilitate an intuitive discussion between domain experts and modelers. Furthermore, Hand-crafting causality graphs, integrating human expertise with robust statistical methodology, enables ensuring responsible AI practices.

The paper focuses on using multiplicity-adjusted p-values, controlling for the false discovery rate (FDR), as an aid for co-designing the graph. A family of hypotheses relevant to causal graph construction is identified, including assessing correlation strengths, directions of causal effects, and how well an estimated structural causal model induces the observed covariance structure.

An iterative flow is described where an initial causal graph is drafted based on expert beliefs about likely causal relationships. The subject matter expert's beliefs, communicated as ranked scores could be incorporated into the control of the measure proposed by Benjamini and Kling, the FDCR (False Discovery Cost Rate). The FDCR-adjusted p-values then provide feedback on which parts of the graph are supported or contradicted by the data. This co-design process continues, adding, removing, or revising arcs in the graph, until the expert and modeler converge on a satisfactory causal structure grounded in both domain knowledge and data evidence.

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The 'je ne sais quoi' of algorithms that foster human centric analytics design

Dr Christina Phillips

Liverpool John Moores University

Parallel 8 - Responsible OR and AI, LR4, September 12, 2024, 11:00 - 12:30

Biography:

Dr. Christina J. Phillips is a Senior Lecturer in Business Analytics at the Liverpool Business School, Liverpool John Moores University. She has a diverse background, having tutored in physics and statistics, run her own art and design company, and consulted in business analytics. Her expertise is in mathematical modelling, extended to participative modelling and design. Dr. Phillips' recent work involves Human Centric Analytics design and the development of AI for healthcare, specifically addressing misinformation during the Covid-19 pandemic. She has also contributed to

the fields of analytics design, participative analytics development, and lean development in semi-process industries. Additionally, Dr. Phillips is involved in collaborative metric/process design for ESG reporting and health systems design. She holds previous positions at the University of Leeds and Siemens Healthineers, has been co-chair of the Problem Structuring Methods SIG at ORS for a number of years and is involved in the OR in Practice SIG as their Senior Designer. She also sits on the Board of Directors of the society as a trustee and represents the SIGs on General Council. This March Dr. Phillips will be taking over as Co-Chair of the Analytics Network.

There have been developments recently in interpretable and explainable AI as well as moves to understand ways to do human centred analytics design. As technology and the use of algorithms in business become more ubiquitous, we need to understand what parameters in algorithm design can facilitate human centred approaches. Ways to do this ethically and sustainably become ever more pressing as business moves into a world of ESG reporting and increasingly cybernetic systems.

This talk initially outlines the parameters (defined by prior research) needed by algorithms and AI/ML techniques that make them amenable to integration with human practice. We then take a quick look at the philosophical underpinnings needed by research into cross paradigm work. This sets the stage for a tour of some currently available mathematical tools and techniques that can work with human practice and the contexts they are likely to work under.

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Operationalising Organisational AI Governance: From Principles to Practice

James Winters

Parallel 9 - Responsible OR and AI - KEYNOTE, LR4, September 12, 2024, 13:30 - 15:00

Biography:

James Winters is AI Governance Officer and an AI Management Consultant at Deeper Insights, a boutique AI Consultancy and Technology provider.

He is also pursuing a part-time Law PHD at the University of Northumbria, on the topic of AI Governance.

James works on a project and organisational level, across business, technical and legal domains to help organisations build strategies and operational routes for the Responsible and Governed development, implementation and management of AI systems.

He leads internal AI Governance and Assurance policies, processes and mechanisms at Deeper Insights and supports cross industry organisations to build bespoke organisational management control systems for AI.

Previously, James worked in various roles at IBM across Data & AI Governance and Trustworthy AI, both internally and with clients at the project and organisational level.

In recent years the power and use of Artificial Intelligence has grown exponentially. This has brought about a growing salience of the risks and potential negative consequences of the technologies use, across industrial contexts. This, in combination with emerging regulatory requirements and standards, has highlighted the necessity for good governance.

Research and best practice across Industrial organisations, NGO's and academia are fast developing. These efforts focus on how to shape policy and development and ensure that AI is used and developed responsibly. Up until recent times, much focus has been paid to creating ethical frameworks. It is only in recent years with the 'third wave' of ethical AI, that these frameworks and efforts have focused on practical applications.

This session will focus on organisational AI governance and how cross-industry organisations are building effective strategies to operationalise their AI Governance initiatives and priorities.

The talk will explore key topics across legal, business and technology domains, including; mitigating and managing AI risk, roles and responsibilities, processes and organisational structures and technical approaches for responsible AI at the model level.

The talk will aim to demystify the complex and quickly evolving landscape of AI Governance, based on both academic research and 5 years of industry experience in the space.

Soft OR & Problem Structuring Methods

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The complexities of digitising spare parts manufacturing supply chains – Using the VIPLAN methodology to facilitate within a problem situation

Dr Adrian Small, Dr Alireza Shokri, Dr Marcelo Martins Sa, Dr Sadaat Yawar, Ms Obiye Ada-Ibrama
Northumbria University

Parallel 4 - Soft OR & Problem Structuring Methods, The R. Willims Parry (OSCRA), September 11, 2024, 09:00 - 10:30

Biography:

Adrian is an Associate Professor of Operations Management and the research group lead for the Decision-Making research group within Newcastle Business School, Northumbria University. His main research activities are focused around the areas of process improvement, continuous improvement, Lean and Lean implementation in both manufacturing and service contexts. Adrian also undertakes research in problem structuring methods (PSM), Digitalization, Industry 4.0, and Resilience.

With the introduction of Industry 4.0 and 5.0, and supply chain digitalisation, the use of technology has been argued to enable supply chains to become more resilient and productive. This study aims to investigate the multifaceted approach to functional capabilities and readiness for utilising a Digital Test Bed (DTB) in the end-to-end multi-tier spare part manufacturing supply chain. A digital test bed could be argued to be associated with Industry 4.0. This work adopted participatory action research (PAR) as it attempted to solve the practical problems of supply chain digitisation, is participatory in nature, and aims to create a learning environment as well as contribute to knowledge (Westbrook, 1995; Baskerville and WoodHarper, 1996; Coughlan and Coughlan, 2002; Baskerville and Myers, 2004; Chaitanya and Clegg, 2021). The focus of this study was on several individuals of different organisations within the supply chain. As a consequence, the learning on supply chain digitalisation and what functionality a proposed digital supply chain test bed needed to incorporate was collective and concentrated on change (Yoong and Gallupe, 2001). The many stakeholders engaged in the project had different perspectives and worldviews on what any test bed needs to do and the features it needs to incorporate. This posed a complex and messy problem. In order to help structure this problem, the VIPLAN methodology (Espejo et al., 1999; Harwood, 2021, 2023) was used a way to think about and facilitate the problem situation.

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Configuring systems to be viable in a crisis: The role of intuitive decision-making

Ayham Fattoum

Parallel 4 - Soft OR & Problem Structuring Methods, The R. Willims Parry (OSCRA), September 11, 2024, 09:00 - 10:30

Decision-making in complex systems becomes even more challenging when the environment creates volatile, uncertain, complex, and ambiguous conditions that disrupt operations. In these settings, the viable system model (VSM) advocates that delegated autonomy, appropriately calibrated, can help decision-makers deal with disruptions quickly to preserve system viability and performance. However, the delegated authority to act also requires the confidence and knowledge to make effective decisions and, in this vein, we explore the role of intuition as an enabler of autonomy in emergency response systems. Intuition allows decision-makers who confront a novel situation to translate their experience, knowledge, and protocols in creative ways – innovations permitted by their delegated authority. This study contributes to VSM literature by a) demonstrating how VSM's structure and complexity management principles can support the analysis of viability in multi-agency emergency systems and b) using VSM to design a systems model to explain the role of autonomy and intuition in supporting decision-making and complexity management in viable systems. Methodologically, the study uses a multi-stage discovery-oriented approach (DOA) to develop theory, with each stage combining literature, data analysis, and model/theory development and identifying further questions to inform the subsequent stage. Through the DOA, we synthesise literature (e.g. on VSM, complexity management) with seven months of field-based insights (from interviews, workshops, and observation of a live disaster exercise) to develop VSM models. This research makes two contributions to soft operational research (OR) literature: taking a black-box approach to theory development in soft OR to uncover the role of autonomy and intuition in managing complexity and demonstrating DOA as a methodology that can provide fresh insights for behavioural soft OR studies.

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The Design of Viable Supply Chains. A Reflection through the Viable System Model

Dr Eliseo Vilalta-Perdomo¹, Dr Rosario Michel-Villarreal², Dr David Salinas-Navarro¹¹Aston University. Aston Business School, ²University of Leeds. School of Earth and Environment. Sustainability Research Institute

Parallel 4 - Soft OR & Problem Structuring Methods, The R. Willims Parry (OSCRA), September 11, 2024, 09:00 - 10:30

Biography:

My research focuses on how to improve individual and collective performance, in those cases where the alignment of aims and preferences is unattainable, undesirable, nonessential or even unnecessary. I am currently studying the development of sustainable communities of micro-producers, so that they are more resistant to global and / or local logistical challenges. Therefore, I am exploring different human and technological interfaces, within different supply arrangements, that may increase the propensity of individuals to collaborate. In short, my current research is at the intersection of issues such as human performance, technology and sustainable operations.

This work aims to make clear the implications of designing viable supply chains. This notion of viability emerges from the work on cybernetics management developed by Stafford Beer (1972, 1975, 1979, 1985), which has been capriciously extended by Ivanov (2020) into the supply chain management (SCM) literature. Such extension, whilst interesting and challenging, does not seem to follow Beer's original work; hence, a detailed consideration of the implications of the use of the original notion demands a more detailed explanation.

Design/methodology/approach.

The Viable System Model (VSM) is formally used to support the analysis of how viable a SC is, and what can be done to increase such viability. The rationale behind the selection of VSM to map SCs considers two assumptions. First, viable organizations arise when people successfully work together in the long term despite the effects of environmental disturbances (Espejo et al. 1999). Second, to achieve such viability the maximum autonomy needs to be recognized to avoid the breaking of the system (Beer 1993).

A real case of a mapping of a SC by means of VSM is provided. An example of its implementation is presented and discussed (Vilalta-Perdomo et al, 2022).

Findings.

VSM is a robust systemic approach to analysing the interfaces between the different organizations that constitute a SC. It can be used to consider ways to increase the viability of SC in extreme conditions, such as the ones presented during COVID-19.

Relevance/contribution.

This work will contribute to the starting debate on what a Viable Supply Chain might be, and how it might be improved and maintained in the long term.

A mapping between SCs and the systemic functions included in the VSM can help to exemplify how to design effective interfaces between the different participants of a Viable SC.

Conclusion

Viability is a concept that has a specific meaning within Beer's work. Its use in SCM literature and research is interesting but intriguing. This work offers some light on what VSM can do for the

mapping of Viable SCs and how effective interfaces between SC members can be built through a robust systemic approach.

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Exploring Sustainable Objectives for the Socioenvironmental Challenges of the Native Peoples of Southeast Pará, Brazil: A Value-Focused Approach.

Dr Nissia Bergiante¹, Dr. Mischel Carmen Belderrain², Professor Jonatas Araujo de Almeida³, Dr. Juliana Alves, Dr. Ailson Picanço⁵

¹Fluminense Federal University (UFF), ²Aeronautics Institute of Technology (ITA), ³Pernambuco Federal University (UFPE), ⁴State University of Tocantins (UNITINS), ⁵State University of Para (UEPA)

Parallel 5 -Soft OR & Problem Structuring, The R.Willims Parry (OSCRA), September 11, 2024, 11:00 - 12:30

Biography:

She holds a Bachelor's degree in Production Engineering from the Federal Fluminense University (2005), an MBA in Occupational Safety Engineering (2008), Project Management (2009), and Planning and Implementation of Distance Education (2011). She holds a Master's degree in Production Engineering from the same university (2008) and a Ph.D. in Transportation Engineering from COPPE/UFRJ (2013). She completed a postdoctoral internship at the Aeronautics Institute of Technology (2017). She is currently an Associate Professor II in the Department of Production Engineering at the Federal Fluminense University. She has experience in the field of Production Engineering, with emphasis on Operations Management (Process Improvement, Layout, and Lean Production), Problem Structuring Methods - Soft Operational Research and System Dynamics. In the region of Southeast Pará, Brazil, native peoples are confronted with a myriad of multifaceted socioenvironmental challenges that transcend the boundaries of local geography, encompass the richness of cultural diversity, and are shaped not only by climate change, but also by access to natural resources, territorial conflicts, including mining and water use, and the influences of economic crises in the country. This study aims to address these challenges from a fresh perspective, employing the Value-Focused Thinking methodological approach. The objective is to identify and prioritize the core values of these communities and other stakeholders, in order to guide the formulation of objectives that outline future solutions promoting their well-being and sustainability. Through documentary analysis, the aim is to understand the needs and aspirations, placing their values at the heart of the decision-making process. This value-centered approach not only seeks to address the immediate problems faced by native peoples, but also aims to ensure that their voices are heard and their perspectives are duly considered in development policies and projects. The ultimate outcome will be a set of sustainable and culturally sensitive objectives that

reflect the values and priorities of local communities, thereby contributing to the construction of a fairer and more equitable future for all involved.

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Enhancing Organizational Efficiency through Soft Systems Methodology: A Case Study of the British Psychological Society

Professor Ho Law¹

¹Empsy Limited, ²The British Psychological Society, ³The Operational Research Society
Parallel 5 -Soft OR & Problem Structuring, The R.Williams Parry (OSCRA), September 11, 2024, 11:00
- 12:30

Biography:

Empsy® (Empowerment Psychology), the company founded by Ho, provides a full range of psychological services in coaching, consulting, mentoring, and training to empower people, places, and the planet. It won the Social Care Award in 2022 & 2023 as the Best Mental Health Coaching Consultancy – East of England. Formerly a senior scientist and the inaugural equality advisor to the Assistant Permanent Under Secretary of State in the Research, Development & Statistics Directorate of the Home Office and Cabinet Office (COBRE) with over 40 years of consultancy experience, Ho is steadfast in promoting and enhancing the accessibility of psychology to address post-pandemic challenges. Ho champions mental health and social prescribing in communities, exemplified by his voluntary work in the Chinese community in Peterborough, earning the first King's Award for Voluntary Service in 2023. Ho is currently the BPS Psychotherapy Section Chair and Review Editor, supervising a dozen of research doctoral students and advocating a new narrative action research and systems approach, while dividing his time between research, supervision, writing, and family.

This presentation integrates Soft Systems Methodology (SSM) with the learning process to analyse and optimize a complex organization, using the British Psychological Society (BPS) as a case study. The primary aim is to facilitate organizational change, with objectives to optimize functions by minimizing resources, and enhance operational efficiency and organizational impact.

For over 120 years, the BPS has been a champion for psychology and psychological professionals, supporting its 65,000+ members throughout their careers. The organization's impact is vast, influencing everything from government policy to everyday advertising, reflecting the growing demand for psychological services.

The BPS functions include:

1. **Support:** Providing members with tools and resources to advance their careers through the latest research, continuing professional development (CPD) opportunities, and tailored events.
2. **Advocacy:** Acting as a progressive voice for psychology and psychologists, influencing policy-making with a psychological perspective that prioritizes people.
3. **Connectivity:** Offering networking opportunities to facilitate collaboration among members.

The BPS's organizational structure comprises a Board of Trustees, which is the primary governing body responsible for the society's management and legal obligations. The Board includes the President, President-Elect, Chair, Chair of Senate, Chairs of Strategy Boards, and up to five additional trustees (elected and appointed).

The Senior Management Team oversees five main boards reporting to the Board of Trustees:

1. Education and Training Board
2. Equality, Diversity, and Inclusion Board
3. Member Board
4. Practice Board
5. Research Board

It is a large organization that can be described by the SSM as a 'complex problematical' situation. The case study aims to understand the BPS from a systems perspective, identify issues such as conflicts, contradictions, and irrationalities, and propose changes for improvement.

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A practical guide to problem solving and evidence gathering in Government Operational Research

Dr Ben Follows
HMRC

Parallel 5 -Soft OR & Problem Structuring, The R.Willims Parry (OSCRA), September 11, 2024, 11:00 - 12:30

Biography:

Ben is a senior Operational Research manager with experience working within the Government Operational Research Service (GORS) mainly for HM Revenue and Customs. Ben's current role involves leading specialist teams to deliver innovative systems thinking, data exploitation and data analytics solutions to address complex business problems. Ben's work often focusses on leading teams to provide analysis and research to inform transformation and service design. For example, Ben led the analytical teams to provide award winning analysis and publication of the scale of error and fraud in the coronavirus job retention (furlough) scheme and the self-employment income support scheme. Ben is the HMRC lead for the GORS-led Systems Thinking Interest Group (STIG) and a Fellow of the Operational Research Society.

Decision making in Government is often complex and fast paced. Government Operational Researchers play a vital role during the initial problem-solving phase. Our work involves assembling a variety of hard and soft evidence, illustrating uncertainties and setting out a plan for improving the understanding of a particular operational or policy challenge. A key skill for Operational Researchers is therefore the ability to work with the initial uncertainty and a lack of strong evidence, to enable decision-makers to make informed decisions, based on balanced

information. The Operational Research toolkit is well suited to gathering a variety of data and facilitating constructive conversations particularly when problems are multi-layered, information is sparse, and tipping points or trade-offs are relevant.

We often sense the increased profile and importance of the policy or operational change when the pace increases. This presentation provides a pragmatic 'field guide' for Operational Researchers looking to inform decisions whilst responding to initial pressure, including staying in the game, and navigating towards more sophisticated analysis. The presentation will include references to a wide range of tools including Estimation, Monte Carlo Simulation, Delphi, Multi Criteria Decision Analysis, Systems Thinking, Evaluation and Evidence Levels.

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Understanding Socioeconomic Systems Behaviour Using the Novel Resource Agent Maps (RAM) Problem Structuring Method

Dr Rossen Kazakov¹, Ms Penka Petrova², Ms Yavora Kazakova²

¹Heriot Watt University, ²Scenario Simlab

Parallel 6 - Soft OR & Problem Structuring, G1 Main Arts, September 11, 2024, 13:30 - 15:00

Biography:

PhD in Management Science

Socioeconomic systems are complex adaptive systems and in order to understand their behaviour a novel problem structuring method is proposed: Resource Agent Maps (RAM). RAM is a hybrid qualitative modelling method integrating the concepts of resources and agents and their interrelations. In their EJOR paper (Kazakov et al., 2021), introduced the RAM method and its capabilities to support the analyses and management of complex adaptive systems, which behaviours emerge through the dialectical interactions between resources and agents.

RAM include first, the development of a Resource Map, supported by the Resource-based Theory (RBT) and the Resource Dependence Theory (RDT) which maps key internal and external resources, their structure, influencing factors and feedback interrelations; and second, the development of an Agent Map, containing both an Agent interaction map (AiM), which maps key agents, their interrelations, influencing factors and identifying the agents' main behavioural rules, and an Agent behavioural map (AbM), which maps agents' behavioural decision action pattern in more detail, revealing each agent's cognitive structure informed by the Behavioural Decision Theory (BDT) and the Anticipatory Systems Theory (AST); finally, the enhanced RM and AM are integrated to produce a hybrid RAM.

The presentation will include practical applications in healthcare and pharmaceuticals, finance, art and culture, sociology and education, which are included in a Springer Contributions to

Management Science book, titled "Understanding and Managing Socioeconomic Systems" (Kazakov, Petrova and Kazakova, 2024), ISBN 978-3-031-57056-8.

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Towards the Development of a Problem Structuring Platform Supported by Machine Learning

Professor Mike Yearworth

Grounded Systems, University of Exeter

Parallel 6 - Soft OR & Problem Structuring, G1 Main Arts, September 11, 2024, 13:30 - 15:00

Biography:

Grounded Systems Ltd was founded by Mike Yearworth in 2008. Mike has a background in engineering and management and is Emeritus Professor of Management Science at the University of Exeter.

Mike works with organisations on the following:

Leading workshops with senior leadership teams for planning, transforming and strategy-making
Problem structuring through stakeholder workshops supported by online group support systems
Multi-organisational collaboration

Mike's preferred way of facilitating workshops with leadership teams is to work online in one-to-one 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) based on modelling purpose with a how/why dialectic, process performance scoring, and argumentation Causal Loop Diagrams Multimethodologies
I argue for the contribution that two machine learning techniques can make to the operation of an online Group Support System (GSS) leading to the notion of a Problem Structuring Platform. Probabilistic topic modelling can be used to classify very large quantities of documents, as a form of Augmented Qualitative Analysis (AQA), with a view to building preliminary causal maps for use in a GSS. Large Language Models (LLMs) can be used to elicit general knowledge about problem contexts through the use of directed prompts. When these techniques are combined with the ideas of a scaffold component to help participants self-facilitate through a problem structuring process the possibility opens up for a Problem Structuring Platform with potential for achieving i) scale-up to large group workshops, ii) rapid deployment in fast-paced decision environments, and iii) arbitrating and moderating participant behaviours for ensuring procedural rationality and justice.

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Reflections on Opportunities to Innovate Policy using Problem Structuring Methods to Transform UK Public Sector Organisations

Sophie Jackson, Mr Martin Parr, Adam Townsend

Parallel 6 - Soft OR & Problem Structuring, G1 Main Arts, September 11, 2024, 13:30 - 15:00

Biography:

Martin Parr is the co-founder and owner of Guided Systems Solutions. Martin is appointed to Portsmouth University as the Royal Academy of Engineering Visiting Professor in Systems Thinking and Management for Engineering and Artificial Intelligence. Martin has worked for over 20 years as a consultant on complex projects, many of which have been delivered for the UK public sector.

Martin has delivered consultancy work to organisations including the UK Cabinet Office, UK Department for Education, and UK Ministry of Defence. 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 for 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 established the first UK level 7 apprenticeship in systems thinking and 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, the Operational Research Society and the Institute of Leadership. Outside work Martin is Chair of Governors at a large primary school in Farnham, Surrey. Martin loves music and plays the piano and organ.

Martin is an expert on systems thinking and has designed the curriculum for the UK's first L7 systems thinking apprenticeship. Martin has worked for over 20 years as a consultant on complex projects, many of which have been delivered for the UK public sector. Martin has provided advice to a number of programmes with annual budgets of over £1bn, and has taken a systems approach to reviewing the governance arrangements for GMPP with a whole life cost of around £600bn. Martin is a Visiting Fellow at Cranfield University and the Department for Education. Martin hosts the Evolving Enterprises podcast.

In the UK our public sector services are described as being delivered efficiently. Each project will have been funded based on needs, but at a macroeconomic level there is great opportunity to make improvements. So, why don't we make these changes? In part because it is difficult and the benefits won't be seen by the people who deliver the change. There is also no enduring structure and mandate within government to perform systemic change, although there is a structure for

audit – highlighting more focus on risk than on the opportunity. Transformational change is possible and innovation is achievable. There are many opportunities to design policy to realise significant benefits, but we lack political will and appropriate control systems. A simple assessment can be obtained by comparing publicly available reports from key UK agencies such as The Metropolitan Police. It can easily be shown that there is a wide gap between the mission for each organisation and what they deliver. In considering systems level improvements, a project will be examined using methodologies such the Viable System Model (VSM). This project will demonstrate that there is a need to develop policy using systems approaches. It will highlight the broader opportunities that may be possible, and that transformational change can be delivered for the UK government.

Strategic Decision Making and Policy Making

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Scenario Simulation for Policy Planning, Prospective Evaluation, Implementation and Management of Circular Economy Transitions and Viable Pathway Options Using Integrated SD and AI Approach

Dr Rossen Kazakov, Professor Bing Xu

Heriot Watt University

Parallel 1 - Strategic Decision Making and Policy Making, LR1, September 10, 2024, 10:30 - 12:00

Biography:

PhD in Management Science

Scenario Simulation for policy planning, prospective evaluation, implementation and management of circular economy transitions and viable pathway options is proposed by using an integrated SD and AI simulation decision support tool, enabling the prospective evaluation of the impacts of policy interventions aimed to transit the conventional linear economy to a new circular economy framework. A system dynamics simulator is being developed which will enable stakeholders to assess the effects of policy decisions, in relation to the desired behavioural changes. By employing simulation scenarios that consider alternative policies, the tool facilitates the evaluation of potential shifts in investment patterns and consumer preferences, and explores which are the most important levers that can create and make use of the system key turning points, in order to realise the system's transition using optimal transition pathways. The use of AI algorithms enhance the SD scenario simulator by analyzing real time data, identifying changes in the behavioural patterns that feed into the simulator, enabling learning and adapting this interactive tool to changing conditions, endogenous or exogenous to the simulated system and integrating these changes in the prospective scenario simulations.

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Reflexive exploration of Scenario Planning pedagogy.

Dr Eleanor Reynolds

Warwick Business School

Parallel 1 - Strategic Decision Making and Policy Making, LR1, September 10, 2024, 10:30 - 12:00

Biography:

Eleanor Reynolds is a Teaching Fellow in the Information Systems, Management and Analytics Group at Warwick Business School, where her teaching focuses upon problem structuring and strategy development.

Eleanor's PhD studies at Warwick Business School explored problem structuring (PS) in an everyday workplace, and her progress and findings have been presented at various national and international OR conferences. Eleanor also holds an MSc in Business Analytics and Consulting and a BSc in Management Science.

Prior to her research, Eleanor spent 12 years working in the water industry, during which time she was involved in structuring many problematic situations. Spanning analytics, project management and strategy development, her work has consistently focused upon the collaborative negotiation of change agendas. Highlights have included partnership working within Defra's catchment-based approach to improving UK watercourses and leading Severn Trent Water's operational Scenario Planning and wastewater strategy development process.

This paper explores difference in approaches to teaching Scenario Planning. A selection of mature taught study modules is accessed to compare learning objectives, seeking insight into contrasts within the pedagogy developed. This is expanded into a reflexive, tutor-informed commentary on how these teaching approaches and learning objectives are relevant to the student cohorts for whom these modules have been developed. Representing the early stages of this exploration into the pedagogy of Scenario Planning, the reflexive element of this comparison will be developed further. Attendees are invited to reflect upon these initial examples, share experiences of teaching and practicing Scenario Planning, and consider participating in future discussions.

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Improving Planning and Regulation for Sustainable Growth in Aquaculture and Fisheries: A New Policy and Strategic Plan for Niger State

Mr John Soje

Valu8 Consulting Limited

Parallel 1 - Strategic Decision Making and Policy Making, LR1, September 10, 2024, 10:30 - 12:00

Biography:

Experienced professional with over 18 years in operational research and business analysis, spanning Financial Services (Nigeria and UK) and Government.

A decision maker's ally, known for guiding cross-functional teams to improve processes, and fostering data-driven culture and partnerships to provide actionable insights to senior stakeholders.

I am proficient in data analysis and insights, strategy, and risk management. A certified Prince 2 project management professional with good stakeholder management and facilitation experience, adept at leading transformative initiatives and fostering partnerships in agile environments.

I have worked with NatWest Plc in various roles across the Risk and Finance domain since 2018.

- Spearheaded analysis and insights into credit impairments and portfolio quality to senior colleagues and governance committees. This often involved interpreting complex data and IFRS9 methodology into easily understandable insights for improving governance and risk decisions.
- Facilitating transformative initiatives in technology to improve solutions for regulatory reporting (e.g adoption of cloud).
- My career in the UK Financial Services began in 2014 with Tesco Bank as a credit analyst. This was a career change from the Civil Service - where I worked as an operational research/business analyst in different roles across Health (managing NHS performance, e.g. waiting times etc.), Fisheries and Aquaculture (economic impact assessments of regulations etc.) and Defence (Scottish Independence white paper - Defence and Security).
- The change enhanced my knowledge of the commercial environment, ultimately deepening my skills in business analysis, finance, risk, and stakeholder management.
- I value family (3 children and an extended family....) and supporting communities – involved in grass-root football and other initiatives. I am passionate about applying smart technologies, business analysis, and policy-making skills to support sustainable growth objectives for agriculture in Sub-Saharan Africa. I am developing a consultancy service to drive these initiatives.

Globally, wild catch fisheries face substantial challenges, including diminishing stocks due to fishing malpractices, piracy, and environmental factors (FAO). Recognizing these issues, aquaculture emerges as a viable solution to address the gap between seafood consumption and production, but in a way that is environmentally, socially, and economically sustainable.

Effective fisheries management policies are crucial for sustaining marine ecosystems and supporting communities reliant on fisheries. In Nigeria, existing national and regional policies highlight aquaculture's potential in building a sustainable food system. However, these policies often emphasize wild catch fisheries, lacking stakeholder inclusion, comprehensive plans for implementation, and data-driven decision-making.

This presentation outlines the participatory approach used in developing a new aquaculture policy for Niger State. The policymaking process involved three stages: initiation, planning, and selection of management actions aligned with strategic priorities for sustainable economic growth. This approach balances environmental concerns to minimize risks to biodiversity and local communities.

A combination of methods in strategy management (including data and strategy analysis) were applied across all stages of the policy development, from policy initiation through to the documentation of the strategic framework. This approach ensured the key stakeholders (producers, processors, government agencies, etc.) were involved in the policy-making process.

Through extensive consultations and workshops, stakeholders identified key issues and envisioned the sector's future. The resulting policy focuses on five strategic priorities: (i) Improved value chain and better markets, (ii) Healthier Fish - Quality and Standards, (iii) Improved systems for aquaculture planning, (iv) Access to Finance, and (v) Improved Governance and partnerships.

Supported by the USAID Feed the Future (FtF) Nigeria Agribusiness Investment (NAI), this policy establishes clear mechanisms for implementation, ensuring stakeholder support. It charts a path to harness the state's abundant aquatic resources and become a resilient, competitive, and environmentally responsible sector, setting a standard for protection, sustainability, and quality.

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Behavioural Aspects of System Dynamics use with Scenarios

Martin Kunc

University Of Southampton

Parallel 2 - Strategic Decision Making and Policy Making, LR1, September 10, 2024, 13:00 - 14:00

Biography:

Professor of business analytics, Southampton Business School, University of Southampton.

System dynamics (SD) is a methodology to generate qualitative and quantitative models. SD has two main concepts that are highly suitable to use with scenarios: feedback processes that define the structure of sociotechnical systems and accumulation processes that are responsible for the dynamic behaviour of systems over time. Kunc (2023) proposes framework that integrates methodologically scenarios and SD where the integration can take multiple forms depending on the use of SD for creating or supporting scenarios. Lane (2017) proposes a behavioural focus for SD in terms of its contributions related to mental models, encountering the world, building and implementing formal models, and content of formal models. This work evaluates how the behavioural focus of SD can support overcome some of the behavioural issues in scenario development process such as cognitive biases, effective group facilitation and overcoming business-as-usual thinking (Bryson et al, 2016)

Bryson, S., Grime, M., Murthy, A., & Wright, G. (2016). Behavioral issues in the practical application of scenario thinking: Cognitive biases, effective group facilitation and overcoming business-as-usual thinking. In M. Kunc, L. White, & J. Malpass (Eds.), Behavioral operational research: Theory, methodology and practice. Palgrave.

Lane DC. 2017. 'Behavioural System Dynamics': A very tentative and slightly sceptical map of the territory Systems Research and Behavioral Science 34(4)

Kunc, M. (2023). Integrating system dynamics and scenarios: A framework based on personal experience. Futures & Foresight Science, e174.

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Foresight approaches for future health shocks: integration into policy making and research priorities

Professor Christina Pagel¹, Dr Duncan Robertson^{2,4}, Dr Kit Yates³

¹University College London, ²Loughborough Business School, ³University of Bath, ⁴St Catherine's College, University of Oxford

Parallel 2 - Strategic Decision Making and Policy Making, LR1, September 10, 2024, 13:00 - 14:00

Biography:

Christina Pagel is Professor of Operational Research (a branch of very applied mathematics) at University College London, using mathematical tools to support delivery of health services. She runs a large programme of research to understand and communicate outcomes in congenital heart disease.

She is also co-director of the UCL CHIMERA hub where researchers will examine anonymised data to develop a better understanding of how people's physiology changes during intensive care and co-lead of the UCL SPROCKET project aiming to improve services for children with complex health needs.

Since May 2020, she has been a member of Independent SAGE, a group of scientists working together to provide up to date information for the public on the COVID-19 crisis. At the height of the pandemic, this included giving weekly public live-streamed briefings on the latest covid and many interviews in print and broadcast media, nationally and internationally.

The UK's pandemic preparedness has deficiencies, as covid-19 showed, particularly in the speed of response and recognition of the severity of the emergency at the highest level of decision making.

Foresight approaches are key to emergency preparedness but they must be integrated within policy making at all levels. We suggest six principles for successful integration while also highlighting key areas for future research within each principle.

The six key principles are:

- An articulated set of fundamental values and clearly defined objectives that would underly policy making in an emergency.
- Embedding systems thinking in the policy making process.

- Developing long-term resilience, which requires continuous investment.
- Involve decision makers from the start
- Practising situational awareness
- A broad range of stakeholders and expertise should be included.

Finally we reflect on an over-arching research gap, which is how to accommodate emergency preparedness within the reality of politics as well as policy. How do we support resilient, long term (often decades) policy making within short term electoral cycles and concerns? How do we support choosing optimal policies, in line with articulated values and objectives, if they conflict with the current political situation?

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An Open Systems-Based Methodology for Strategy Design

Mr Andrew Firth, Andrew Leggatt, Jason Poole, Paddy Turner

Parallel 3 - Strategic Decision & Policy making, LR1, September 10, 2024, 14:10 - 15:10

Systems thinking is gaining traction and momentum in academia and application. And yet, at the base level, the prevailing mental model of a system is arguably drawn from mechanical engineering where a system is the sum of its interacting parts. Organic social systems are far from mechanical, of course, and often present in ways that appear to be more than the sum of the parts. It is extremely difficult to predict the behaviour of an organic social system, a difficulty that increases exponentially for more complex systems, and still more because all organic systems are adaptive and susceptible to a range of often unknown stimuli.

Conventional approaches to strategy formulation remain linear and mechanistic; if one has certain objectives and one carries out specified activities, then one will achieve one's goal. Such thinking is supreme fallacy in the face of complex adaptation. As every market is by nature a complex adaptive system, then it is no wonder that most conventional approaches to strategy are ineffective. The 'systems-thinking' community offers various models and tools in an attempt to shift the conventional paradigm. Few of these approaches are 'end-to-end' methodologies, however, providing a conceptual framework for the design of strategic engagement from analysing the problem statement and its context to initiating and managing engagement with a system of interest.

Based on over twenty years of research and practical experience, including in complex environments as provided by the military and the health sector, the authors offer their 'Four Frames' approach to strategy design as an end-to-end methodology to educate and enhance open

systems thinking. This paper outlines the key tenets of the approach, including the critical importance of managing emergent conditions in a system once it has been engaged and how that might be done. The 'Four Frames' approach offers a paradigm-shifting lens through which to view the challenges of strategy design and systems-influence

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Systems Thinking and Strategic Management: Potential synergies

Martin Kunc

University Of Southampton

Parallel 3 - Strategic Decision & Policy making, LR1, September 10, 2024, 14:10 - 15:10

Biography:

Professor of Management Science, Southampton Business School

The paper presents a review of the field of Systems Thinking and Strategic Management in terms of areas of interest with the objective to identify synergies given both fields deal with similar organizational problems. The evolution of the areas of interest between Systems Thinking and Strategic Management follows similar patterns with more prescriptive developments occurring within the 1960s until 1980s, then an increasing focus on emergence and transformation emerged in later years. From the review, there seems to exist strong synergies for the use of the multiple strands existing in Systems Thinking with Strategic Management. Suggestions to facilitate the interaction between both fields is proposed. Hopefully, the paper can contribute to the development of a more systemic approach to manage organizations and society.

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Implementing Vehicle Scrappage Policy in Developing Economies with Informal Recycling Centers with Diverse Producers Abstract

Mr Karthik Ramaswamy¹

1IIM Bangalore

Poster Presentations, The Eric Sunderland LT, September 11, 2024, 11:00 - 12:00

Biography:

I am Karthik Ramaswamy Doctoral Student from the Indian Institute of Management Bangalore.

My research interests include addressing social and environmental issues in Global supply chains through game theoretic methods.

Academic/Practical Relevance: The problem of building ELV recycling infrastructure in developing economies in the presence of informal scrapping centres and diverse producers pose unique challenges and have not been explored in depth in academia or in practice. In this study, we fill this void by exploring the heterogeneity of the producers in terms of product recovery and Subsidy

and provide insights into optimizing recycling and subsidy efforts in regions with the above specific challenges.

Methodology: As a benchmark, we first consider two kinds of Independent Recycling Systems, one in which a producer "i" retrieves his ELVs through a subsidy based on a chosen level of responsibility and recycles them from a unique recycler and in the other a producer recycles his product by owning a recycling facility. Second, we consider a Collective Recycling System (with Proportional/CPR profit sharing) with two heterogeneous producers recycling their retrieved products through a common recycler or by owning a recycling facility. Finally, we consider a collective recycling system with homogeneous producers (offering the same subsidy) where they recycle their ELVs either through a third-party recycler or by owning a recycling facility.

Results: Using a Stackelberg game theoretic model, our analysis reveals the following: (a) Under specific conditions, a collective recycling system with CPR profit sharing with two heterogeneous producers leads to higher product recovery and recycling efficiency compared to the corresponding Individual recycling systems. (c) Finally, we find that under a set of conditions collective recycling systems with homogeneous producers lead to the highest number of product recoveries and recycling efficiency compared to all other corresponding recycling systems.

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Design of a Performance-Based Learning System for the British Red Cross

Dr Richard Jackson, Philippa Johnson

Decision Analysis Services Ltd

Parallel 7 - Strategic Decision Making and Policy Making, LR3, September 12, 2024, 09:00 - 10:30

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.

Decision Analysis Services Ltd (DAS) was commissioned by the British Red Cross (BRC) to support the design and implementation of a new performance-based learning system to evaluate the delivery of their key strategic and operational objectives. A fishbone framework was designed and used together with document reviews and interviews to evaluate the current "as-is" performance-based system. Through a series of cross-organisational workshops and consultations, a set of design principles and potential initiatives for the "to-be" system were identified. Initiatives were prioritised and implemented. These include the design of a dashboard, which visualises a balanced scorecard, learnings, and achievements.

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Exploring the use of SWOT within a workshop setting

Dr Frances O'Brien¹, Professor Maureen Meadows²

¹University Of Warwick, ²Coventry University

Parallel 7 - Strategic Decision Making and Policy Making, LR3, September 12, 2024, 09:00 - 10:30

Biography:

Frances O'Brien is an Associate Professor of OR & Analytics at Warwick Business School. Her research interests are the development and use of tools to support organisational strategic development.

This paper explores video data of a strategy workshop using SWOT analysis within a training exercise for senior managers. The authors document, and reflect upon, the use of strategy tools during the exercise. The paper therefore addresses a gap in the extant literature concerning how strategy tools such as SWOT are used in practice. A framework is developed that relates the use of artefacts, such as flipcharts and post-it notes, to both the style of facilitation (controlled or uncontrolled) and the stage of strategic conversation (convergent or divergent). The study also proposes that when senior managers work with SWOT, a number of stages of activity can be identified, which are summarised here as designing the tool, forming the tool, using the tool and communicating with the tool.

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Enhancing Military Fleet Readiness through Integrated Maintenance Management Systems

Dr Congzheng Liu

Decision Lab

Parallel 7 - Strategic Decision Making and Policy Making, LR3, September 12, 2024, 09:00 - 10:30

Biography:

Joshua is an experienced consultant, expertise in Supply Chain Management with 8+ years experience. He focuses on developing integrated forecasting models for inventory management problems, especially for perishable products. He is highly active in the academic field, published multiple research papers on top-level journals.

In an era where rapid deployment and operational readiness are critical for military effectiveness, the maintenance management of military fleets stands as a pivotal strategic function. We create a system that applies an innovative approach to the maintenance management of diverse military vehicles stationed globally, ensuring their readiness for immediate deployment. Our approach bifurcates maintenance into routine and condition-based interventions, utilising advanced analytical models to optimise maintenance schedules and predict vehicular maintenance needs.

In particular, we utilise optimisation models for scheduling and machine learning algorithms for condition prediction. These algorithms analyse data from General Dynamics' Health and Usage Monitoring Systems (HUMS) to pre-emptively identify potential breakdowns, enabling strategic maintenance planning.

Moreover, we create a simulation-based user interface that allows stakeholders to visualize and compare different maintenance scenarios, thereby supporting informed decision-making in strategic contexts. Our system not only improves operational readiness but also demonstrates the potential for predictive maintenance to optimise resource utilisation across various high-readiness sectors.

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Leveraging competition in e-commerce: A game-theoretic approach to analyse seller's strategic behaviour

Dr. Srivatsa Srinivas S, Dr. Vinay Reddy Venumuddala

Indian Institute Of Technology Jodhpur

Parallel 8 - Strategic Decision Making and Policy Making, The Kate Roberts (OSCRB), September 12, 2024, 11:00 - 12:30

Biography:

S. Srivatsa Srinivas is an Assistant Professor in the Centre for Mathematical and Computational Economics (CMCE), School of AI and Data Science (SAIDE) at IIT Jodhpur. He completed his M.S. and Ph.D. in Applied Game Theory and Operations Research at the Department of Management Studies, IIT Madras. His doctoral thesis focused on analyzing queueing game-theoretic problems in the service operations context. During his doctoral studies, he was a recipient of the prestigious Institute Research Award presented by IIT Madras to select doctoral scholars. He held a short research associate position post Ph.D. in the Production & Quantitative Methods Area at IIM Ahmedabad. Earlier, he completed his B.E. Industrial Engineering at the College of Engineering, Guindy with a University Gold Medal. His areas of interest include queueing game theory, services and logistics management, public policy modeling, and game theory applications.

The demand for online shopping has risen significantly over the last few decades with the arrival of e-commerce platforms and its share in the total retail sales is rising each year. However, this spurt in online demand through e-commerce platforms has largely benefitted the large sellers over the small sellers. In the ensuing strategic environment consisting of the small seller and the platform, the small seller is forced to concede an unfair share to the e-commerce platform in addition to accepting the other demands of the platform in facilitating the online transaction. It is imperative for the small seller to consider and leverage possible strategies to overcome this situation. In this study, we aim to analyse one such strategy which involves leveraging the competition faced by the e-commerce platform in the form of a non-strategic public platform. We develop a game-theoretic approach to this strategic environment consisting of the small seller and

the platform and obtain equilibrium conditions under which the smaller seller benefits by adopting such a strategy. We focus on the strategic pricing behaviour of the small seller and the platform and perform extensive analysis using game theory and simulation to understand this behaviour. Our results indicate that the seller does benefit by leveraging the competition between platforms. This equilibrium is impacted by the seller's variable costs, processing charges on the platforms and the competition intensity faced by the platform. In such an environment, the small seller benefits significantly by leveraging competition which is further augmented by decreased variable costs and processing charges.

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When Is It Wise to Use Blockchain for Remanufacturing with Government Subsidy

Mr Qi Sun^{1,2}, Miss Yumin Fu³

¹University Of Dundee, ²China University of Petroleum, ³Qingdao University

Parallel 8 - Strategic Decision Making and Policy Making, The Kate Roberts (OSCRB), September 12, 2024, 11:00 - 12:30

Biography:

Qi Sun is a PHD student from China University of Petroleum and now visiting University Of Dundee as a visiting scholar. His research interest includes sustainable supply chain management and platform supply chain.

This study explores the blockchain application and government subsidy decisions in a remanufacturing supply chain comprising a manufacturer and a recycler under the government subsidy. The manufacturer decides whether to adopt blockchain technology to save remanufacturing cost, while the government chooses a subsidy policy between unit recycling subsidy (URS) and investment subsidy (IS). We find that employing blockchain effectively enhances the collection rate so that lowers the operational cost. Interestingly, adopting blockchain technology and government's subsidy policy are complementary, and therefore managers should not ignore the impact of one decision on the other decision even when the latter is not a primary motivation of the former. This study represents a significant stride towards the integration of blockchain in production and underscores collaboration with government to offer guidelines for effectively promoting sustainable goal.

Supply Chain and Operations Management

Optimising a multi objective mathematical model for bioenergy supply chain design

Maryam Rudneshim, Amanda Sosa

Parallel 1 - Supply Chain and Operations Management, Welsh Seminar Room, September 10, 2024, 10:30 - 12:00

In alignment with the United Nations' Sustainable Development Goals, particularly the objective to secure clean, affordable, and sustainable energy" for all, this study embarks on a crucial exploration of alternative energy solutions amidst the global push for energy diversification and climate change mitigation. The utilisation of seaweed and agricultural waste as a bioenergy source stands out as a strategic opportunity to enhance environmental sustainability and foster renewable energy production within the framework of a circular bioeconomy. The core of this initiative's success hinges on informed decision-making in designing supply chains that are robust, efficient, and sustainable. This research introduces an innovative decision-making framework aimed at optimising the supply chain network for seaweeds and agricultural waste-to bioenergy conversion, with a particular focus on the decision analysis for selecting biorefinery locations. Employing an integrated approach that combines Geographic Information System (GIS) with Multi-Criteria Decision Making (MCDM), the study delineates optimal sites for biorefineries. This decision-making process meticulously considers both economic and environmental factors to propose a model that aligns with the principles of sustainability. Through this approach, the study seeks to influence stakeholders and investors by demonstrating the feasibility and attractiveness of bioenergy projects, thereby advancing the goals of the circular bioeconomy and contributing to the broader agenda of the sustainable energy transition.

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Optimizing food grains stock movement among Indian states

Mr. Atul Sharma¹, Dr Nomes Bolia²

¹Indian Institute of Technology (IIT) Delhi, ²Indian Institute of Technology (IIT) Delhi

Parallel 1 - Supply Chain and Operations Management, Welsh Seminar Room, September 10, 2024, 10:30 - 12:00

Biography:

Atul Sharma is a Ph.D. scholar specializing in Industrial Engineering and Operations Research (IEOR) at the prestigious Indian Institute of Technology (IIT) Delhi. He has completed his Bachelor's degree in Mechanical Engineering from the National Institute of Technology (NIT) Kurukshetra. His academic interests lie in the areas of Mathematical Modelling, Integer Programming (IP), and

applied Operations Research. His focus is on enhancing decision-making processes and improving the efficiency of government schemes. He is passionate about extending the applications of OR to diverse domains such as health, environment, judiciary, and electoral systems. He is currently engaged in a project with the Government of India, focusing on optimizing transportation routes for food grain stocks using Operations Research techniques. He also brings with him valuable experience in project management gained from his work experience at L&T Defence Systems. While at L&T, he was actively involved in coordinating with various business departments such as Design, Supply Chain, Quality, and Logistics to ensure the timely execution of projects and delivery of deliverables to customers. His industry experience also provided him with valuable exposure to the field of Industrial Hydraulics and automation. With a passion for research and a strong academic background, he aims to contribute significantly to the field of Industrial Engineering and Operations Research (IEOR). During his free time, he enjoys watching TV series and listening to music (both Western and Indian classics). You can reach out to him on social media on Twitter at @AtulSharma497 or on LinkedIn at <http://linkedin.com/in/atul-sharma-56383a166>.

This paper offers insights into the monthly planning of food grain distribution by the organisation responsible for the nationwide food grain movement in India. Presently, the organisational methodology for monthly planning involves discussions with various regional managers over conference calls to manually balance supply and demand. A balanced transportation model is then employed to determine the allocation of food grains between different regions, with each region serving as a fundamental entity. This paper proposes an optimal monthly plan based on which the daily operations can take place. A mathematical model is formulated as a mixed integer linear programming (MILP) model with an objective to minimize the transportation cost expenditure for monthly movement of food grains stocks, significantly enhancing the conventional approach by considering each railhead (RH) as a fundamental entity. Railways play a crucial role in food grain distribution, as the majority of food grains throughout India are transported via railways. By incorporating RH as the basic entity, the model can account for railway constraints, such as two-point destination, TEFD (Traditional Empty Flow Directions), and the maximum number of rakes per railhead which are impossible to comprehend with the conventional region-to-region approach, rendering this approach implementable at the ground level. Unlike the conventional approach, the model can also accommodate scenarios where supply is more than the total demand (usually the case), something not possible under the current balancing approach. It can also incorporate the procurement and anticipated offtake per railhead, thereby providing more practically implementable results. The results offer an optimal monthly implementable plan considering various systemic real-life constraints including those from railways. This approach is advantageous as it provides all regions with information regarding supply and demand at the railhead level in advance, enabling them to plan effectively and avoid last-minute adjustments that result in increased transportation costs. The railhead-to-railhead data can be further consolidated to produce region-to-region plan.

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Advanced Booking of Agriculture Input Products – An Analytical Examination

Mr Diwakar Kumar Pandey, Prof Saurabh Chandra, Dr Debabrata Ghosh¹

¹Indian Institute of Management Indore, ²Indian Institute of Management Indore, ³University of Essex

Parallel 1 - Supply Chain and Operations Management, Welsh Seminar Room, September 10, 2024, 10:30 - 12:00

Biography:

Dr Debabrata Ghosh is a Reader in the Strategy, Operations and Entrepreneurship Group (SOE) and the Director of Executive Education at Essex Business School. Prior to this, Dr Ghosh held faculty positions at the Malaysia Institute for Supply Chain Innovation (a part of the MIT SCALE Network), Asia School of Business (in collaboration with MIT Sloan) and the Indian Institute of Management Calcutta (AACSB, AMBA, EQUIS), top business schools in Malaysia and India, respectively.

Dr Ghosh's research interests lie in the areas of supply chain analytics, sustainable operations, supply contracts, emerging economies, game-theoretic applications in operations and OM-Marketing interface models.

This paper examines advanced booking (AB) in agricultural input supply chains considering a single commodity, a manufacturer and wholesaler, with AB discounts and sales effort-dependent stochastic demand. The manufacturer decides his manufacturing quantity, while the wholesaler decides her AB quantity and sales effort. A comparison of decision outcomes in a game-theoretic setting shows that the manufacturer is always better off being the Stackelberg follower. We also find when the commodity selling price is low and the AB discount is high, the wholesaler Stackelberg model creates a win-win for both the players and the supply chain.

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Analysis of Critical Success Factors for Sustainable Green Supply Chain Management Using Interpretive Structural Modeling

Mr Ali Shirouyehzad¹, Dr Hamid Reza Panjeh Fouladgaran², Dr Hadi Shirouyehzad¹

¹Islamic Azad University Najafabad Branch, ²Liverpool Business School, Liverpool John Moores University

Parallel 7 - Supply Chain and Operations Management, LR1, September 12, 2024, 09:00 - 10:30

Biography:

Dr. Hamid Reza Panjeh Fouladgaran is a senior lecturer in Operations Management and Quality at Liverpool Business School. He has PhD in Industrial Engineering, an MSc of Industrial and Systems

Engineering, and a BSc of Industrial Engineering with a Minor in Industrial Production. Hamid boasts more than 13 years of experience in Higher Education. Prior to joining LJMU in 2019, he was a lecturer in the Department of Management at Sunway University, Malaysia, from 2016 to 2018. Hamid doctoral research focused on developing a framework for reverse logistics risk management. He undertakes research with a focus on sustainable supply chain management, supply chain risk management, and supply chain strategies. He has supervised several undergraduate and postgraduate students over the past few years. Moreover, he is contributing as a guest editor and peer reviewer in some academic journals such as Sustainability, Management Decision, Journal of Modelling in Management, Asia Pacific Journal of Business Administration, International Journal of Logistics Systems and Management, International Journal of Services and Operations Management, and International Journal of Productivity and Quality Management, etc. Over the past decade, green supply chain management has emerged as one of the influential concepts in sustainable development for organisations. Green supply chain management can positively impact organisations' productivity and environmental efficiency. Given the importance of this topic, identifying critical success factors for a sustainable green supply chain, as well as prioritizing and categorising these factors for resource management in organisations, is crucial.

In this study, based on the critical success factors identified by Agrawal et al. (2022) and the application of experts' opinions, the critical success factors for a sustainable green supply chain are categorised and ranked. Interpretive Structural Modeling (ISM), a graphical representation method for complex systems, is used to identify the impactful and affected factors in green supply chain management. Additionally, the MICMAC method is employed to categorise these success factors..

In this study, nine critical success factors for green supply chain management are extracted from the literature: top management commitment, adoption of new technology and processes, customer requirements, employee involvement, brand image building, government regulations and standards, training, reverse logistics management, and sustainability. The results of the study illustrate that top management commitment and training are the most impactful factors. Moreover, brand image and sustainability are the most affected factors among these nine critical success factors. The MICMAC method categorizes these nine factors into four groups. The result of the MICMAC analysis shows that the most impactful factors for achieving green supply chain management are training, employee involvement, and top management commitment.

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Scheduling and Routing for Aerial Firefighting under Degradation-Triggered Fire Spread

Dr Erdi Dasdemir¹, Dr Rajan Batta², Esther Jose²

¹Hacettepe University & University of Southampton, ²University at Buffalo

Parallel 7 - Supply Chain and Operations Management, LR1, September 12, 2024, 09:00 - 10:30

Biography:

Erdi Dasedemir is affiliated with the Department of Industrial Engineering at Hacettepe University, Turkiye, and is currently serving as a visiting researcher at the University of Southampton for the summer of 2024. During his time in Southampton, he is collaborating with Dr. Bismark Singh to expand this study to encompass multiple objectives and uncertainties. His research focuses on mathematical modeling, multi-objective optimization, and evolutionary algorithms, specializing in addressing routing challenges for both manned and unmanned vehicles.

We address a scheduling and routing problem where new jobs emerge during the operational phase due to the degradation of existing jobs. Specifically, given a set of potential job locations, the demand for an existing job increases over time, and once it exceeds a specific threshold, it triggers the arrival of new jobs at other locations. An unprocessed job at any location progressively reduces the value of the location, and the overall objective is to maximize the total remaining reward across the entire region. The underlying motivation of this problem aligns with the proverb "A stitch in time saves nine." The problem finds practical application in aerial forest firefighting. In this context, timely intervention in existing fires by aerial vehicles is critical to prevent the spread of fires and to maximize the preservation of value in threatened regions. A comprehensive mathematical optimization model is developed and its performance is validated through computational experiments. The model is then demonstrated across various scenarios in a case study based on California wildfires. The results of the computational experiments demonstrate the significant impact of fleet size and vehicle speed on both the computational performance of the model and the operational success.

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Districting and Capacitated Multi-operator Routing Problems in Urban Areas with Replenishment Stops

Dr. Diego Ruiz-Hernández¹, Dr. Jesus Pinar-Pérez, Dr. Amaya Erro-Garcés, Mr. Marcos Resano
¹Sheffield University Management School

Parallel 7 - Supply Chain and Operations Management, LR1, September 12, 2024, 09:00 - 10:30

Biography:

Diego Ruiz-Hernández holds a PhD in Operational Research from the Universitat Pompeu Fabra in Catalonia. He is currently Senior Lecturer in Management Science at Sheffield University Management School and Programme Director of MSc Management.

His research covers, but is not limited to, fields in the areas of mathematical programming, combinatorial optimisation, discrete and network location, stochastic scheduling, and dynamic resource allocation.

Diego is a member of the Sheffield Universities Military Education Committee, and Co-chair of the Yorkshire and the Humber Regional Group of the OR Society.

This work is the result of the collaboration between Elkarkide, a company in the advertisement distribution sector, Sheffield University Management School, the Universidad Pública de Navarra, and CUNEF Universidad. Elkarkide delivers brochures, leaflets, and catalogues in urban and rural areas. The company operates in the north of Spain and works with post-men and women who suffer from serious psychiatric diseases.

The objective of our collaboration was to help Elkarkide improve their distribution strategy while taking into consideration the special needs of the distribution teams. In particular, we worked together on redefining the distribution districts and finding more efficient routes for the operators.

The problem faced by Elkarkide was modelled as an arc routing problem (a variant of the so-called Chinese postman problem), where operators are expected to traverse (and serve) the complete set of arcs in their delivery region. Given the computational complexity of the problem, we developed a heuristic approach that provides good quality and meaningful solutions for the problem. The first step in our approach is to define a number of regions for delivery and to allocate a team of operators to each of them. Given the capacity constraints, the operators must make several stops to replenish their trolleys. This requires a second step consisting of the segmentation of the region into delivery areas. Once the areas have been defined, the third step consists of determining the location of the replenishment points. Finally, the routes to be covered by each operator within their region, and in each subsequent area, are designed.

Overall, we have dealt with a very complex problem that combines districting, location, and arc-routing problems. A solution heuristic was developed by our team, and currently it's being implemented by Elkarkide.

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Designing for circularity: a reverse logistics network of post-consumption fashion to evaluate the impact of policy interventions

Mrs Marjan Olfati, Professor Afshin Mansouri

Brunel University London

Parallel 8 - Supply Chain and Operations Management, LR1, September 12, 2024, 11:00 - 12:30

Biography:

Marjan Olfati is a PhD student of management studies research at Brunel Business School (BBS). She received her MSc in Industrial engineering from the Iran University of Science and Technology, Iran. Her master's thesis was "Designing and solving a reverse logistics network for polyethylene

terephthalate bottles". Throughout her MSc and after that, Marjan has published four papers on the field of operations research and mathematical modelling. She started her doctoral studies in October 2023. In her PhD thesis, Marjan explores the role of reverse logistics as an enabler of circular economy in the fashion industry. She particularly looks at the interactions among the players of the post-consumption supply network of pre-owned clothing products through the lens of mathematical modelling, optimisation and game theory. At the conference, Marjan will be speaking on a reverse logistics network of post-consumption fashion to evaluate the impact of policy interventions. Her goal is to uncover the opportunities for making the fashion industry circular through coordination and collaboration among the key stakeholders of the post-consumption supply network of clothing products and policy interventions by the government and local authorities.

Due to the proliferation of fast fashion, post-consumption clothing waste as one of the major pollutants has raised many concerns worldwide. Establishing a circular fashion using the Re-x strategies will likely curb post-consumption clothing-related issues. Designing an effective reverse logistics network adopting appropriate policies and a circular economy drives various clothing stakeholders and decision-makers to make optimal decisions beyond a linear supply chain. It leads to keeping products in the cycle and reusing them as long as possible instead of following the "take-make-dispose" approach. In the first stage, this paper presents a systematic review of the literature on the textile and fashion industry in three key areas: (i) reverse logistics, (ii) circular economy, and (iii) policy interventions. The first area emphasises optimisation and operations research models as well as game theory models. The second one highlights the implementation of the circular economy and sustainability. The third area looks into the possibility of employing policy interventions, such as EPR, taxation, subsidy, and transparency. Building on the outcomes of the systematic literature review, a preliminary model is developed for a multi-level clothing reverse logistics network. Subsequently, a policy such as the Extended Producer Responsibility (EPR) for post-consumption clothing is implemented and its benefit on the supply chain is explored. To verify the applicability of the model, a numerical example is conducted. The results provide managerial insights for policymakers and stakeholders of the clothing industry to decrease costs and environmental impacts and foster a sustainable circular fashion.

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Adaptive AI Decision Agents for Holistic Supply Chain Optimisation: Merging Societal and Business Objectives

Rifny Rachman¹, Prof. Richard Allmendinger¹, Josh Tingey², Pradyumn Shukla¹, Wei Pan¹

¹University Of Manchester, ²Peak

Parallel 8 - Supply Chain and Operations Management, LR1, September 12, 2024, 11:00 - 12:30

Biography:

Rifny is a PhD student at the Centre for Doctoral Training (CDT) in Data Analytics at the University of Manchester. With an academic background in Industrial Engineering, specialising in Industrial System Planning and Optimisation, Rifny has a keen interest in leveraging data analytics to enhance manufacturing and supply chain operations.

Having worked as a Material and Process Optimisation Manager in the FMCG industry, Rifny brings practical experience to his academic pursuits. Her research focuses on areas such as manufacturing and supply chain optimisation, supply chain network design, and transportation & warehousing. Additionally, Rifny is passionate about exploring the application of artificial intelligence in operational research to improve efficiency and decision-making processes.

Through her academic journey and professional experience, Rifny is committed to contributing innovative solutions to real-world challenges in the field of data analytics and supply chain management. She looks forward to sharing her research findings and insights at the international conference, fostering collaboration and knowledge exchange within the academic and industrial communities.

We present a supply chain (SC) optimisation that considers three pillars of sustainability, i.e., economic, environmental, and societal. The trade-offs of the three objectives are calculated by maximising profit, minimising greenhouse gas (GHG) emissions, and minimising service level inequality simultaneously. Our SC domain incorporates four echelon facilities and stochastic demands from three markets. To address the problem, the supply chain environment is formulated using a Markov Decision Process (MDP) and an optimisation-based model as comparison separately. The former implements a Multi-Objective Reinforcement Learning (MORL) method using MORL based on Decomposition (MORL/D) algorithm and a single-objective Reinforcement Learning (RL) algorithm called Proximal Policy Optimisation (PPO) with multiple weights. Meanwhile, a multi-objective meta-heuristic algorithm, namely NSGA-II, is utilised to solve the latter. Decision variables include the quantity of production and delivery of all routes. Each approach resulted in a set of Pareto Front, which represents the best trade-off solutions. Our contributions are a formal definition of a three-objective SC upon a Multi-objective MDP (MOMDP), an introduction to a customisable supply environment Python module called messiah, the first application of MORL/D algorithm in multi-objective SC domain, and an analysis of its comparison with a single-objective RL, and metaheuristic methods in SC domain. The current result suggests that MORL and RL solutions outperform NSGA-II. Additionally, PPO results in higher hypervolume and expected utility measurement (EUM) than MORL/D. However, the latter exhibits a denser solution set and offers more solutions that are closer to a desirable combined objective value.

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Subscription-Based Inventory Planning for E-Grocery Retailing

David Winkelmann¹, Charlotte Köhler²

¹Bielefeld University, ²European University Viadrina

Parallel 8 - Supply Chain and Operations Management, LR1, September 12, 2024, 11:00 - 12:30

Biography:

My PhD thesis covers the application of advanced analytics to questions on logistics operations and sports economics.

The growing e-grocery sector faces challenges in becoming profitable due to heightened customer expectations and logistical complexities. This paper addresses the impact of uncertainty in customer demand on inventory planning for online grocery retailers. Given the perishable nature of grocery products and intense market competition, retailers must ensure product availability while minimising overstocking costs. We propose introducing subscription offers as a solution to mitigate these inventory challenges. Unlike existing literature focusing on uniform subscription models that may harm profitability, our approach considers the synergy between implementing product subscriptions and cost savings from improved inventory planning. We present a three-step procedure enabling retailers to understand uncertainty costs, quantify the value of gathering additional planning information, and implement profitability-enhancing subscription offers. This holistic approach ensures the development of sustainable subscription models in the e-grocery domain.

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Using Sector-Index Data to Model Demand Allocation for Capacity and Production Planning

Professor Shu-jung Sunny Yang¹, Dr Yingying Huang, Professor Teck Yong Eng

¹School for Business and Society, University of York, ²School of Management, Harbin Institute of Technology, ³Henley Business School, University of Reading Malaysia

Parallel 9 - Supply Chain and Operations Management, LR1, September 12, 2024, 13:30 - 15:00

Biography:

Shu-Jung Sunny Yang is Professor and Chair in Operations Management at the School for Business and Society, University of York. Prior to joining York, he held faculty positions at the University of Melbourne, University of Essex, University of Oslo, University of Southampton, and National Taiwan University. He has held a variety of administrative roles in the academic career, including the department head, institute head, research centre director, and taught programme directors. He received a PhD in Management from the Australian Graduate School of Management (AGSM), University of Sydney and University of New South Wales.

He studies operations strategy, supply chain management, and operations interfaces by combining methods from formal theory, data science, and operational research. He has taught operations strategy, operations management, and supply chain management at various levels. His work has been published in *Manufacturing & Service Operations Management*, *Production and Operations Management*, *Journal of Retailing*, *European Journal of Operational Research*, and *IEEE Transactions on Engineering Management*, among others. His latest book “Building Resilience: Consistent Re-rationalisation in Digital Transformation and Business Inheritance” was published by *CommonWealth Magazine* (Taiwan’s most influential economic news media), and received the 2022 Golden Book Award from the Ministry of Economic Affairs of Taiwan.

He received the 2004 Sasakawa Young Leader Fellow from the Nippon and Tokyo Foundations of Japan, the finalist for the 2012 Future Research Leaders Scheme from the Economic and Social Research Council of the UK, and the 2019 Ta-Yu Wu Memorial Award (the highest honour for outstanding young scholars in Taiwan) from the Ministry of Science and Technology of Taiwan. He holds the editorial positions at *Journal of General Management* and *Journal of Management and Systems*. He is currently a guest editor of *Transportation Research Part E: Logistics and Transportation Review*.

Demand allocation (DA) is a market mechanism that a firm needs to consider in its sales and operations planning (SOP) because the market falls far short of perfect competition. The current analytics challenge in jointly evaluating demand planning (DP) and capacity and production planning (CPP) to realize a firm’s SOP process in such a market is to successfully identify a suitable DA mechanism that shows how to split total industry demand among competing firms in the same sector. We develop a sector-index approach to DA using aggregated financial data to predict the firm-level DP. With this novel analytics approach, we develop a data-driven operations model of CPP to derive the optimal data-dependent capacity-expansion and production decisions. We demonstrate the practical value in a case study of the semiconductor sector and find significant linkages between capacity expansion and sector-index share. We show that a firm’s sector index increases its capacity-expansion size, thereby decreasing its sector-index share. Our findings suggest that a high-index-share firm proactively expands more capacity than low-index-share firms, but its expansion may not increase its market value if the lead time is neither short nor long.

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Probabilistic Control for Reducing the Bullwhip Effect in Recycling-Enhanced Supply Chains

Dr Christos Papanagnou¹, Dr Randa Herzallah²

¹Aston University, ²University of Warwick

Parallel 9 - Supply Chain and Operations Management, LR1, September 12, 2024, 13:30 - 15:00

Biography:

Christos Papanagnou is a Senior Lecturer in Logistics Engineering at the Engineering Systems and Supply Chain Management Group. He is the Programme Director for MSc in Supply Chain Management and MSc in Engineering Management. He serves also the Group as the Research & Enterprise Lead (External). He obtained an MSc in Information Engineering and a PhD in Control Engineering at the City University of London while his postgraduate studies were funded by the Greek State Scholarship Foundation (IKY). He is also a Fellow of the Higher Education Academy.

Dr Papanagnou was actively involved in various research projects funded by Horizon 2020, European Regional Development Fund (ERDF), Innovate UK and Santander Universities. He has acted as Evaluator in Regional Digital Health Accelerator Projects and Horizon 2020/Europe Marie Skłodowska-Curie Actions. His research interests focus on supply chain systems dynamics and applying control theory to alleviate disruption phenomena, including demand volatility and the bullwhip effect. He is very keen on applying advanced tools and techniques based on OR, stochastic systems and big data analytics to improve inventory management and distribution of products and information along the supply chain. Furthermore, he investigates the challenges and opportunities for companies to embrace Industry 4.x and the Internet of Things in the supply chain and manufacturing environments.

Dr Papanagnou is a member of the Operational Research (OR) Society, he has been an advisory member of the European Commission Technical Working Group on best environmental management practices in the car manufacturing sector and a stakeholder for the Flexible Manufacturing SIG Workshop at Advanced Manufacturing Research Centre. He is a member of the Advisory Board for the International Journal of Strategic Engineering Advisory Board and was awarded the CILT(UK) LRN Conference 2022 Professor Martin Christopher Best Paper Award Research Excellence.

This study introduces a decision-making methodology employing probabilistic control to reduce the bullwhip effect within recycling-inclusive closed-loop supply chains. Replenishment policies are refined to incorporate recycling operations, and probabilistic controllers are utilised to manage inventory and information flow dynamics. We construct a state space model that encompasses inventory levels, information flow, and recycling activities, capturing their complex interrelations. This model is analysed under stationary conditions, with stochastic customer demand characterised using conditional probability density functions, providing insights into supply chain behaviours.

We explore the characteristics of the bullwhip effect and assess the overall stability of the supply chain. Simulations are conducted to evaluate the effectiveness of our probabilistic control strategy in managing and stabilising the supply chain during such disturbances. The ultimate goal is to enhance supply chain efficiency and resilience in the face of uncertainties through this innovative control approach.

Systems Thinking

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Identifying the Fundamental Concepts of Systems Thinking

Mr Matt Lloyd

Centre For Systems Studies, university of Hull

Parallel 1 - Systems Thinking, Drama Rehearsal Room, September 10, 2024, 10:30 - 12:00

Biography:

Matt Lloyd

A competitive and dedicated team player, Matt has represented Great Britain at both Para Ice Hockey and Sitting Volleyball, including at the Turin 2006 Winter Paralympic games.

On the education front Matt has a B.Sc. in Business Information Systems, a M.Sc. in Systems Thinking, and is currently studying towards a PhD at the University of Hull in Systems Science, exploring barriers to SMEs utilising systems thinking within their decision making processes.

As well as undertaking research at the University of Hull, Matt is co-editor of the Centre for Systems Studies newsletter and is a Trustee of the Student Union. Additionally Matt teaches strategy on the University of Hull's online MBA.

Recently Matt has been appointed chair of the Systems Thinking Special Interest Group at The OR Society. In addition Matt is involved in peer reviews for academic journals as well as contributing articles to business publications.

In the past ten years Matt has helped transform and evolve several multi-million pound organisations as well as creating a number of successful sports organisations

Join us for an engaging and interactive workshop aimed at developing an understanding of what constitutes the fundamentals of systems thinking. This session will bring together interested individuals to explore how systems thinking fundamentals are defined and identifying what they are. The workshop will begin with a group activity looking to define what the fundamentals of systems thinking are, followed by a discussion where participants will agree a definition of the fundamentals of systems thinking to be used within the session. The main portion of the workshop will feature an exercise in which participants will collaborate in groups to identify potential fundamentals of systems thinking. To conclude the session, each group will share what they believe are the fundamentals of systems thinking and steps on how the output from this workshop can be utilised to develop a common or shared understanding within the systems community. This workshop offers a unique opportunity for those interested in systems thinking to engage in

discussion over what could be considered the fundamentals of systems thinking with a view to helping develop consensus within the wider systems community.

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Identifying the Components of Systems Thinking

Mr Matt Lloyd

Centre For Systems Studies, University of Hull

Parallel 1 - Systems Thinking, Drama Rehearsal Room, September 10, 2024, 10:30 - 12:00

Biography:

A competitive and dedicated team player, Matt has represented Great Britain at both Para Ice Hockey and Sitting Volleyball, including at the Turin 2006 Winter Paralympic games.

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In the past ten years Matt has helped transform and evolve several multi-million pound organisations, including a number of successful sports organisations.

Systems thinking is a both a well-established multidisciplinary approach to understanding and intervening with messy situations and wicked problems. However, there is considerable debate around what systems thinking actually is, with no agreed definition and no consensus as to what constitutes the associated components. After undertaking a literature review, it has been identified that there are three distinct components: fundamentals, methodologies and tools. The intention is to explore the boundaries between these three components and establish guidelines on how to define a potential systems thinking component, thereby creating a framework that makes it possible for systems thinking fundamentals, methodologies and tools to be clearly delineated.

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Transcending the Paradigmatic Perspective in Supply Chain Management

Mr Daniell Wilden

Swinburne University

Parallel 2 - Systems Thinking, Drama Rehearsal Room, September 10, 2024, 13:00 - 14:00

Biography:

Daniell is a Supply Chain practitioner with over twenty years of experience across Automotive (Toyota), Rail (Train and Tram), and Services (Food and Facilities Management). As part of his PhD research, he advocates the role that Systems Sciences can play in assisting practitioners in managing the Supply Chain, given the continuance of Volatile, Uncertain, Complex, and Ambiguous challenges.

A theme of Daniell's work is offering guidance to Supply Chain practitioners on engaging with Systems Thinking knowledge, critically evaluating their paradigmatic perspective and seeking ways to transcend their extant frame of reference, e.g., from Reductionism to Functionalism and beyond!

His research ambition is to yield more substantive insights given the application of trans-disciplinary knowledge, equipping practitioners to tackle the current and emergent challenges those in the supply chain will face better.

The supply chain practitioner (SCp) faces volatile, uncertain, complex, and ambiguous (VUCA) challenges. The SCp operates in a complex global system with many interrelationships, interdependencies, and interconnections. However, research has identified that the supply chain management discipline is attempting to tackle these VUCA difficulties using an existing paradigmatic perspective that arguably does not keep pace with the current and emergent levels of complication, complexity or chaos. From a Systems perspective, the positions in the literature identified that the discipline of Supply Chain Management resides somewhere between Reductionism and Functionalism (in the Holistic domain).

There is a clear challenge of transcending the paradigm in practice, with two distinct obstacles: i.) recognising where a practitioner may reside relative to their paradigmatic perspective, and ii.) the propensity to transcend from their extant paradigmatic perspective.

To this end, a novel construct termed the 'Reductionistic-Holistic Spectrum' is proffered to identify where a practitioner may reside and what other paradigms they can consider. Therefore, the advent of the Spectrum is intended to assist in determining the array of paradigms that exist across both Reductionism and Holism and offer contextualised guidance to the SCp wherein they

can appreciate their extant position. By understanding their position, we posit they can grasp the associated limitations and seek alternatives to evolve their paradigmatic perspective. The Spectrum utilises extant Systems knowledge, specifically, the Systems of Systems Methodologies, which is augmented to illustrate the paradigms under the Reductionistic domain.

This presentation will share the findings from empirical research derived from a series of semi-structured interviews. The study will explore the positions towards the paradigmatic perspective the SCp resides in and the challenge and opportunity of seeking a transcendence. It is intended that this research will lay the groundwork for future empirical research that draws upon Systems Thinking wherein interventions can be devised that can assist the SCp in making a transcendence from one paradigm to another, e.g., from Functionalism to Interpretivism, with the consequential benefits of being able to tackle a higher order of challenge, given the adoption of an evolved paradigmatic perspective.

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Introducing a means of profiling the systems thinking capabilities within public service organisations.

Mr Christopher Abbott

University of Hull Centre for Systems Studies

Parallel 2 - Systems Thinking, Drama Rehearsal Room, September 10, 2024, 13:00 - 14:00

Biography:

Chris is a Senior Change and Improvement Consultant and Chartered Water and Environmental Manager serving the UK government Department for Environment, Food and Rural Affairs - Defra. He works across the Defra group of agencies and public bodies that include the Environment Agency, the Rural Payments Agency, and Natural England amongst others.

The first ten years of his career involved wearing wellington boots and venturing out in all weathers to battle with pollution in the Southwest of England. Subsequent less muddy roles in customer services, business planning, and performance management lead to a change in trajectory from 2006. The switch came from recognition that a greater impact could be made protecting the environment by helping colleagues to improve the way that they worked. Focused with an unashamed bias towards the human aspects of enabling organisational change at all scales, Chris has likened his work to that of a multi-disciplinary vacuum cleaner, constantly Hoovering up the means and experiences of enabling sustainable improvements in the way work is undertaken, and periodically emptying the bag all over his colleagues.

He is now at the mid-point of part-time doctoral research under supervision from the Centre for Systems Studies at the University of Hull. His research explores the means of profiling the internal

complexity capabilities and needs of public service organisations. This is wrapped around his internal consultancy role in a way that is not without challenges, although these pale into insignificance when considered alongside the unprecedented advantages of researching with an insider appreciation of organisational culture.

This presentation is delivered in two parts. The first concerns understanding how a public service organisation, or a part thereof, is equipped to work with complex challenges, its appetite to add more, and the potential that it might grow into. These insights are codified into a unique profile. The second part concerns the use of this profile to guide subtle, dispersed, and coherent influences that enable growth into that potential. This may be achieved in ways not dissimilar to Aikido's 'harmony of spirit', in so much that it redirects exiting momentum with minimal need for additional energy of its own.

The privilege of working as a change professional across a number of public service organisations provides valuable exposure to the diversity of organisational cultures expressed, and the myriad of subcultures that exist within them. Ignoring this diversity with a one-sized-fits-all approach to effecting change will soon see efforts run aground, and sadly there are far too many wrecks on those rocks already. To avoid them, it's imperative to first understand the culture(s), before thinking about how you might help it/them to embrace change. That principle stands if you have in mind increasing capability for working with tame problems, just as much as it does for wicked ones. This presents an important question: "How do you go about becoming culture savvy?". In this session I will describe a research framework developed to guide the necessary exploration. It draws on the conceptual model of panarchy, originally devised to better understand how ecological systems function, and that has since proved helpful with complex adaptive systems more generally.

The framework shapes a repeatable process for revealing a unique profile. This establishes a common language to enable useful comparisons between profiles, but its primary purpose is to guide bespoke "change Aikido", i.e., a coherent set of subtle changes across a broad front that tip the balance to favour the development of complexity capabilities. Part two illustrates how this Aikido is taking shape in Defra, and within it, how technology is helping to introduce sophisticated ideas to people in innovative ways that don't over-simplify, nor overwhelm.

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Protopian Storytelling: Past-present-future systems thinking

Dr. Kirsten Kainz¹, Emma Kainz²

¹Just Learning Systems, ²Tulane University

Parallel 4 - Systems Thinking, G1 Main Arts, September 11, 2024, 09:00 - 10:30

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 publishes, teaches, and presents 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.

You're probably familiar with the terms utopia (an ideal world) and dystopia (a world that has gone wrong), but there is a new term people are starting to use to describe possible worlds. Protopia, a term coined by the futurist, Kevin Kelley, increasingly refers to a world where people are collaborating to make a better future. This project is about protopian thinking, where we imagine how to co-create desirable futures for our communities using a unique systems thinking lens: past-present-future systems thinking .

Past-present-future systems thinking, developed for this project, combines features of storytelling, empathic listening, and systems thinking for the purpose of engaging and connecting people in community-based groups, priming groups for co-creating future possibilities, and empowering the translation of stories into actions for better and sustainable futures. During OR 66, the presenting author will facilitate a group in Protopian Storytelling using methods that participants can borrow and adapt in their own communities.

We will start with an interesting prompt – what makes a great ancestor? The facilitator will provide some initial definitions, and participants will create individual and collective stories that lead to reflection on what we can do today as great ancestors to future generations.

References

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5. Jere Lazanski, T. (2010, November). Systems thinking: ancient Maya's evolution of consciousness and contemporary systems thinking. In *AIP Conference Proceedings* (Vol. 1303, No. 1, pp. 289-296). American Institute of Physics.

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The Interplay of Ethics and Systems Thinking: A Holistic Approach to Decision-Making

Patricia Jimenez, Dr JIMENA PASCUAL

P. Universidad Catolica De Valparaiso

Parallel 4 - Systems Thinking, G1 Main Arts, September 11, 2024, 09:00 - 10:30

Biography:

Patricia Jimenez is a lecturer in the School of Industrial Engineering at Pontificia Universidad Catolica de Valparaiso in Chile. She is also completing her PhD in Education at Lancaster University. Her research focuses on the intersection of engineering, ethics, management, and education. In her role as a lecturer, Dr. Jimenez is dedicated to preparing the next generation of engineers to navigate the complex ethical and managerial challenges they will face in their careers.

This article reviews the relationship between ethics and systems thinking, utilising James Rest's four-component model of moral behaviour as a theoretical lens. This review aims to explore the interplay between these two fields and highlight the importance of a holistic approach to decision-making in addressing complex challenges.

The review reveals that systems thinking enhances ethical decision-making by encouraging decision-makers to consider the broader context and the potential consequences of their actions on the entire system. Conversely, ethics provides a moral compass for navigating the complexities of systems thinking. It's important to note that James Rest's four-component model of moral behavior, consisting of moral sensitivity, moral judgment, moral motivation, and moral character, serves as a crucial framework for understanding how ethics and systems thinking interact and influence decision-making processes.

Through this review, we identify the key themes and findings that emerge from the literature, including the importance of a holistic approach, the linkage between systems thinking and ethics, and the application of James Rest's model in this context. We conclude that the integration of ethics and systems thinking, guided by Rest's framework, is crucial for developing a comprehensive understanding of the ethical implications of decisions and for promoting the well-being of the entire system. This review contributes to the existing body of knowledge by providing a synthesis of the current understanding of the relationship between ethics and systems thinking, and by highlighting the potential for future research to explore this important intersection further.

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Beyond a checklist: Critical Systems Heuristics for practicing Ubuntu

Prof Roelien Goede

North-west University

Parallel 4 - Systems Thinking, G1 Main Arts, September 11, 2024, 09:00 - 10:30

Biography:

Prof Roelien Goede is the Director of the Unit of Data Science and Computing at the North-West University, South Africa, and a past president of the International Society of Systems Sciences (ISSS). Her research interests are Critical Systems Thinking applied to Business Intelligence and Programming Education. She has a keen interest in research paradigms focusing on applying Action Research in Information Systems Research. She received distinguished teaching awards for her teaching of Computer Programming and received best paper awards for her research in Computer Science Education. Internationally, she has been involved as a systems specialist in project work with the Technical University of Eindhoven on logistical solutions for refugees in the Netherlands.

She has published in journals such as Systemic Practice and Action Research, Systems Research and Behavioural Science (SRBS), Journal of Transdisciplinary Studies and Communications of Computer and Information Science. She was guest editor of the 2020 and 2024 Special Editions of the SRBS, known as the ISSS yearbook. She reviews papers for high-impact journals such as ISJ and SRBS.

She holds a PhD in Information Technology from the University of Pretoria, South Africa. Her PhD focus was on Systems Thinking in Decision Support Systems. She has supervised 8 PhD students and 14 Master's students

Critical systems heuristics (CSH) was developed by Werner Ulrich in 1983 to practice critical systems thinking. The aim of CSH is to improve a problem situation by listening to both the involved and the affected. Ulrich extends the work of Churchman on systems characteristics such as boundary critique and objectives to enable the systems planner to surface underlying assumptions. He created a tool, known as CSH, to guide systems analysts in exploring improvement in problematic situations.

Unfortunately, many practitioners are using the list as a checklist without adopting a critical systems thinking perspective. Ulrich cares deeply about the affected, he is passionate about giving a voice to the marginalised. Ulrich links the underlying critical motivations to the Kantian idea of the totality of conditioned realities.

Systems thinking is about understanding interconnections; about celebrating the emergence when the system is more than the sum of its parts. It is about taking on a wider perspective, taking other perspectives into consideration. These traits of systems thinking are common to the underlying ideas of Ubuntu.

Ubuntu is an African philosophy that celebrates the context of an individual. It recognises the reciprocal role of the context on the actions of the individual in the ontological premises: "I am because we are." It celebrates the possibility of hope, hope for a better future based on the

collaborative efforts of many. Ambassador Elizabeth Frawley Bagley, the United States Secretary of State's Special Representative for Global Partnerships said when she was sworn in in 2009: "This is the Ubuntu Diplomacy where all sectors belong as partners, where we all participate as stakeholders, and where we all succeed together, not incrementally but exponentially".

Adoption of new systems thinking methodologies is slow and cumbersome, which will limit the impact of a new systems methodology for practising Ubuntu. Since CSH already embodies some of the principles of Ubuntu implicitly, it has the potential to be developed as a systems thinking methodology for practising Ubuntu. This paper explores the characteristics of Ubuntu and guides the practice of CSH in a way that embodies the spirit of Ubuntu.

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Systems Pathologies in Institutions of Higher Education in Zimbabwe

Dr Stanislas Bigirimana

Africa University

Parallel 5 - Systems Thinking, G1 Main Arts, September 11, 2024, 11:00 - 12:30

Biography:

Dr Bigirimana, a citizen of Burundi is a Senior Lecturer at the College of Business, Peace, Leadership and Governance at Africa University. He is a holder of Doctor of Philosophy (PhD) from the Ruprecht-Karls-University, Heidelberg (Germany). He is a multi-disciplinary academic who also holds the Masters in Intellectual Property from Africa University; Master's in Business Intelligence from the Chinhoyi University of Technology, a Master of Business Administration and a Master of Arts in Philosophy from the Azaliah University, Albuquerque, New Mexico (USA) and the University of Zimbabwe respectively.

Dr. Bigirimanas' expertise are in Business Intelligence, Management Information Systems, Intellectual Property, Innovation, Entrepreneurship, International Marketing, Organisational Behaviour, Public Sector Management, Cybernetics, and Dynamic and Integrative Epistemology. He has published over 40 journal articles, 3 book chapters and 1 monograph. He has supervised 2 doctoral theses, 60 master's theses and 40 undergraduate dissertations. He has also made presentations at over 50 academic conferences in Africa, Europe and the Americas.

Dr Bigirimana's current research interests are in the areas of Integrating Non-Conventional Intellectual Property Assets in Agricultural and Social Policy for Sustainable Development, The valuation and Exploitation of Intangible Assets, Intellectual Property Rights Protection in New Plant Varieties and Traditional Knowledge Systems, Intellectual Property Protection in Cyberspace, Applications of the viable system model (VSM), Transitioning Institutions of Higher Education towards Education 5.0.

He is a member of the Editorial boards of the International Journal of E-business Research and the Zimbabwe Journal of Economics, Business and Management. He has reviewed for prestigious publishing houses such as Emerald Insight, Sage, Springer and IGI Global. He is the Chairperson of the Board of Trustees of the Information and Communication Technologies Association of Zimbabwe (ICTAZ) and member of the advisor board of the Catholic Commission Justice and Peace (CCJP).

This study aims at assessing the nature and the levels of organisational pathologies in institutions of higher education in Zimbabwe. Through a survey of six institutions of higher education in Zimbabwe, data was collected through questionnaires and interviews with key informants including vice chancellors, faculty deans, academic and administrative staff, parents, guardians and students. This study showed the institutions of higher education assessed suffer from systems pathologies such as bureaucratitis, projectitis, meetingitis, technologitis, conflictitis. This paper suggests the application of the Viable System Model (VSM) as a remedy to these pathologies.

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Enhancing causal loop diagram analysis through network measures: a comprehensive framework and an illustrative case study on maternal and child health systems in Tanzania and Zambia

Dr. Nikita Strelkovskii¹, Dr. Elena Rovenskaya¹, Dr. Josephine Borghi^{1,2}

¹IIASA, ²London School of Hygiene & Tropical Medicine

Parallel 5 - Systems Thinking, G1 Main Arts, September 11, 2024, 11:00 - 12:30

Biography:

Dr. Nikita Strelkovskii is a research scholar in the Cooperation and Transformative Governance (CAT) and Exploratory Modeling of Human-Natural Systems (EM) research groups of the Advancing Systems Analysis (ASA) Program.

Dr. Strelkovskii graduated from the Department of Optimal Control, Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia, in 2012. In 2016 he received his PhD from the Faculty of Computational Mathematics and Cybernetics, Lomonosov Moscow State University, Russia. He joined the ASA program as a research assistant in 2013, and has been a research scholar since 2017.

His research interests include control theory, agent-based modeling and simulations, scenario planning, and systems thinking. He applies his methodological expertise to a broad range of applications like industrial development, economic effects of migration, water resources management, and national well-being.

Causal loop diagrams (CLDs) offer valuable insights into complex systems by illustrating indirect relationships and feedback mechanisms. However, their complexity often poses analytical challenges. We aim to enhance CLD analysis by comprehensively integrating advanced network measures overcoming current limitations such as overlooked link polarities and unreliable component rankings. By systematically reviewing existing applications of network measures to CLD analysis, we identify best practices that address these issues, are implementable in software, accessible to non-experts, and yield actionable policy insights.

We illustrate the application of these approaches to empirical CLDs developed to explore the effects of payment for performance (P4P) schemes, involving health worker incentives, on maternal and child health systems in Tanzania and Zambia. CLDs of MCH systems in both countries were developed and validated using qualitative data from process evaluations and stakeholder dialogues. We apply network measures to the CLDs to identify key health system mechanisms affected by P4P and their impact on the key outcomes, such as the number of women and children receiving incentivized services. We also use network measures to explore variations across two maternal and child health systems in each country, and how these differences influence P4P mechanisms and outcome effects.

This study will demonstrate how network measures can assist in interpreting and comparing CLDs developed in different settings and facilitate the development of simulation models, including opportunities for P4P re-design to further strengthen health systems for better health outcomes.

This research contributes to the field by bridging the divide between CLDs and quantitative system dynamics, offering a comprehensive framework for more effective CLD analysis and use for policy. By leveraging the power of network analysis, we aim to make CLDs more accessible, insightful, and actionable for decision-makers and stakeholders in various domains, ultimately contributing to better understanding and management of complex systems.

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Systemic Approach to the Socio-environmental Conflict of the Native Peoples of Southeast Pará in Brazil

Dr. Mischel Carmen Belderrain¹, Dr Nissia Bergiante², Professor Jonatas Araujo de Almeida³, Professor Juliana Mariano Alves⁴, Professor Ailson Santos Picanço⁵

¹Aeronautics Institute of Technology (ITA), ²Fluminense Federal University (UFF), ³Pernambuco Federal University (UFPE), ⁴State University of Tocantins (UNITINS), ⁵State University of Para (UEPA)

Parallel 5 - Systems Thinking, G1 Main Arts, September 11, 2024, 11:00 - 12:30

Biography:

Full Professor at the Aeronautics Institute of Technology. PhD in Aeronautical and Mechanical Engineering from the Aeronautics Institute of Technology.. Master's in Systems and Computer Engineering from the Federal University of Rio de Janeiro COPPE/UFRJ. Degree in Operations Research - Universidad Nacional Mayor de San Marcos, Lima, Peru. Visiting Research Fellow at the University of St Gallen, Institute of Management, Switzerland, ad-hoc consultant for CAPES and CNPq. Coordinator for ITA of the Operations Research Graduate Program, in association with UNIFESP, for the period (2015-2021). She has experience in the area of Production Engineering, with an emphasis on Operations Research, working mainly on the following topics: Problem Structuring Methods (PSM), Multicriteria Decision Support Methods and Multimethodology. The native peoples of the Amazon, specifically those of the southeastern region of Pará-Brazil, face various social problems due to their geography, cultural and linguistic diversity. In recent years, this situation has worsened in the area of health due to climate change, such as drought and food insecurity, which affect this region. The purpose of this work is to analyze this problematic situation considering the principles of the systems approach, exploring the identification of the elements of the system and the relationships between them.

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Systems Thinking to explore using rail land to transport electricity

Niki Ansari Dogaheh¹, Professor Kathy Kotiadis¹, Professor Thanos Papadopoulos¹, Pelham Walker²

¹University Of Kent, ²High Speed 1

Poster Presentations, The Eric Sunderland LT, September 11, 2024, 11:00 - 12:00

Biography:

Niki Ansari is a graduate of MSc. Business Analytics from the University of Kent and BSc. Aerospace Engineering from K.N. Toosi University of Technology in Tehran, Iran. Her research interests include simulation modelling, sustainability, industrial symbiosis, and facilitated modelling. She can be contacted via email at N.Ansari-Dogaheh@kent.ac.uk.

The UK's plans to reach Net Zero by 2050 requires innovative solutions to enhance renewable electricity generation as well as improving the electricity network's resilience due to increased electricity demands in the near future. This project leverages systems thinking problem structuring tools to explore the potential of placing an electricity cable next to an existing rail line. This proposed development would potentially enhance the grid's resilience and lead to greater opportunities for sustainable generation of energy. For example, the proposed cable could transmit electricity from sources such as solar farms to local businesses, contributing to sustainable energy infrastructure development.

We describe the problem and our engagement with stakeholders in facilitated workshops and our use of rich pictures and mapping tailored to this context. This project demonstrates the integration of the transport system, energy system, and land use, showcasing the effectiveness of

a systems thinking approach in addressing complex, multifaceted issues. The insights gained will inform similar studies and contribute to the broader discourse on systems thinking in operational research.

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CRITICAL SYSTEMS THINKING: A PRACTITIONER'S GUIDE

Professor Mike Jackson

Parallel 6 - Systems Thinking KEYNOTE, Drama Rehearsal Room, September 11, 2024, 13:30 - 15:00

Biography:

Michael C. Jackson is Emeritus Professor at the University of Hull and MD of Systems Research Ltd. He graduated from Oxford University, gained an MA from Lancaster University and a PhD from Hull, and has worked in the civil service, in academia and as a consultant. Between 1999 and 2011, Mike was Dean of Hull University Business School, leading it to triple-crown accreditation. Mike has been President of the International Federation for Systems Research and the International Society for the Systems Sciences. In 2011 Mike was awarded an OBE for services to higher education and business. In 2017 he received the Beale Medal of the UK Operational Research Society for 'a sustained contribution over many years to the theory, practice, and philosophy of Operational Research'. In 2022 he received the Pioneer Award of the International Council on Systems Engineering for 'the development of the foundations of systems engineering as author, educator and intellectual leader in systems thinking'. Mike is known as the leading figure in the development of 'Critical Systems Thinking' - a topic on which he has published ten books and over 150 articles. His latest book *Critical Systems Thinking: A Practitioner's Guide* was published by Wiley in July 2024. He is Co-Chair of the UK Government Office for Science/SCiO 'Systems Thinking Working Group'.

This presentation sets out the argument of my new book 'Critical Systems Thinking: A Practitioner's Guide' (Wiley, 2024). It discusses the need for critical systems thinking; the EPIC framework for guiding multimethodology practice; the barriers standing in the way of implementing systems thinking; and how to overcome those barriers in moving towards a systems thinking world.

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Climate change, natural disasters and global inequality – How systems thinking can help tackle these interrelated challenges

Dr. Gary Preece^{1,2,3}

¹Department for Environment, Food and Rural Affairs (Defra), ²Department for Continuing Education, University of Oxford, ³Disaster Prevention Research Institute (DPRI), Kyoto University

Parallel 7 - Systems Thinking KEYNOTE, Drama Rehearsal Room, September 12, 2024, 09:00 - 10:30

Biography:

Dr. Gary Preece is Head of the Systems Research Programme in the UK Government's Department for Environment, Food and Rural Affairs (Defra). He is also an analyst in the Government Operational Research Service with experience working for a range of government departments in the UK and abroad.

Gary previously worked in academia researching systems thinking and has applied it across a range of domains. He completed his PhD at Aston Business School, focusing on how systems thinking could be used to overcome organisational and information management challenges. At Kyoto University, he explored how systems thinking could support disaster response, and at the University of Oxford he has used systems thinking to examine potential impacts that climate change could have on global inequality.

Gary is a Fellow of the Operational Research Society. He is a previous winner of the OR Society's Elsie Cropper Award, as well as winning other awards from the Government Operational Research Service. His work has been published in the European Journal of Operational Research and the Journal of the Operational Research Society.

Gary has been applying systems thinking and other OR approaches across a range of domains for over 15 years. This keynote address for OR66's Systems Thinking stream will focus on his work applying systems thinking to environmental challenges.

Gary currently heads up the Systems Research Programme for the UK Government's Department for Environment, Food and Rural Affairs (Defra). This programme, started in 2019, provides a dedicated team to support Defra undertake systems thinking research and analysis, supporting policy and decision making across the organisation. The team specialise in applying a range of systems thinking techniques to environmental issues including climate change, food, water and air quality, as well as helping staff across the organisation build their capability in using systems thinking.

Gary's previous work has also looked at applying systems thinking to support natural disaster response and to explore the potential impacts that climate change could have on global inequality.

This talk will look at how systems thinking has supported analysis on these environmental issues, reflect on lessons learnt and highlight future opportunities and challenges for systems thinking on environmental issues and beyond.

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'Lines of Inquiry': A method for preserving the multifaceted value of collective intelligence.

Mr Aydin Asena

Cranfield University

Parallel 8 - Systems Thinking, Drama Rehearsal Room, September 12, 2024, 11:00 - 12:30

Biography:

Aydin Asena is a lecturer in Systems Thinking Practice at Cranfield University, with research interests in forensic linguistics, professional listening, and systems thinking.

The value of collective intelligence (CI) is rooted in the diversity of subject-matter experts' (SMEs') contributions; in the subtle differences that make each contribution unique, rather than in broadly defined patterns of similarity. For instance, 10 different contributors to a CI project will, almost by necessity, use the same word in 10 different ways because the significance of the word is not its dictionary definition but the unique knowledge, experience, and perspective of which it is a partial sign. Thus, "insurance" may be significant as an incentive to one, as regulation to another, and as irrelevant to a third, and so on. To preserve these differences is to preserve the value and purpose of CI: the attainment of a multifaceted appreciation of complex problems. As such, when contributions to CI are processed (to produce reports, briefs, and other outputs), high-fidelity preservation of these differences is a methodological imperative—contributions must be coordinated but not collated; synthesised, but not homogenised, and methodologically sound ways to achieve this are necessary. 'Lines of Inquiry' (conceptual dyads embedded in linguistic context) are proposed here as a tool for coordinating and synthesising contributions to CI, thereby preserving the richness and diversity of information that CI can produce.

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Requirements to be met by a systems approach to organisational governance

Dr Natalie Clewley, Jeremy Hilton

Cranfield University

Parallel 8 - Systems Thinking, Drama Rehearsal Room, September 12, 2024, 11:00 - 12:30

Biography:

Jeremy Hilton is a Senior Lecturer in Complex Systems at Cranfield University where he designed and teaches on the Systems Thinking Practice Apprenticeship Programme. He is a PI on the UKPRP-funded GroundsWell research Programme on the use of Urban Green and Blue Spaces to improve population health, leading the systems work package.

The need to model organisations as systems has been identified in many disciplines, especially socio-technical systems. Safety engineering is one and there are many examples of failures due to assuming reliance on technical controls and not building in the human element. This reinforces the need to consider managerial capability as part of the socio-technical model, because responses cannot be pre-determined for all situations, even though risk assessment/modelling seeks to introduce mitigation which are designed to prevent as many impacts as can be identified. Building on an understanding of complexity (Cilliers, 2002), I explore a range of factors relevant when considering organisations as systems. I draw on a range of thinkers, many who are not part of the contemporary set of systems thinkers though all have a contribution to the complexity of organisations as systems and ensure the requisite complexity of organisations is included within models of systems to ensure requisite regulation. Areas include requisite variety, laminated organisations, the people perspective (levels of capability and the hierarchy of purpose) and environmental interactions.

Requirements identified include: boundary analysis; effects of history and corporate memory; identification of changes within the organisation can be identified as the organisation adapts to environmental changes; being able to determine holistically activities relevant to the agreed purpose and maintain logical dependencies; sub-organisations within the organisation can be identified; being able to determine clusters of elements collaborating at short and range and indicate the longer-range inter-relationships; the identification of measures of performance; feedbacks within the system, between the system and environment and within the environment can be captured; and the organisation can be modelled in its wider context.

Reference:

Cilliers, P. (2002). Complexity and Postmodernism. Taylor & Francis e-Library.

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The 'Boundary Idea' for Sustainability and Sustainable Development

Dr Miles Weaver, Dr Ana Fonseca, Dr Hock Tan

Edinburgh Napier University

Parallel 8 - Systems Thinking, Drama Rehearsal Room, September 12, 2024, 11:00 - 12:30

Biography:

Miles is an Associate Professor in Systems, Sustainability and Supply Chains at The Business School, Edinburgh Napier University.

My research interests are in supporting purposeful business accelerate progress towards the Sustainable Development Goals, including the transition to net zero. By bringing about a meaningful engagement between business and their interdependent stakeholders (individuals, business, communities and nature) to put shared values into purposeful action.

The grand challenges businesses and society face are complex and messy. These challenges are articulated in the 17 United Nations Sustainable Development Goals (SDGs), outlining the economic, social, and environmental goals to be attained by 2030. The SDGs highlight many “wicked problems”, and perhaps the sheer complexity, messiness, interdependences and need for cross-sector and multi-actor working make attaining these goals the ultimate wicked problem (Weaver et al., 2020). Leading organisations such as the UN, OECD, UNESCO, WHO, and other industry sectors declare systems thinking an essential leadership skill (Jackson, 2019). The paper is twofold. Firstly, the authors suggest a review of systems thinking to embed sustainability and its system approach in supporting the actors involved to accelerate the progress towards the SDGs. We introduce the concept of systemic sustainability (first coined by Laszlo and Laszlo, 2011) – moving the actors from ego (purposeful activity from people(s) perspectives) to ecosystems thinking (to co-exist in partnership with the living systems of our environment). Secondly, we propose to advance this concept by incorporating the ‘boundary idea’ and elements of critical systems heuristics (e.g., Ulrich and Reynolds, 2020; Ulrich, 2012a, 2012b). The authors propose that space ought to be available for reconciling differing worldviews to determine where a sense of purposefulness and values come from between stakeholders involved and affected by purposeful business activity. Going beyond a meaningful engagement with stakeholders to truly appreciate business interdependencies with individuals, communities, and nature (including absent voices for future generations and planetary pressures). Towards a circular economy and supply chains that requires systems to be both regenerative and restorative. To do so three critical boundary judgements should be reflected upon: stakeholders issues/concerns; value(s) and impact, opening new avenues for future research.

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The OR Systems Thinking SIG Visioning Workshop: Mapping the Path Forward.

Ms Gemma Smith¹, Mr Christian Heathcote-Elliott²

¹University Of Hull, ²Public Health Wales

Parallel 9 - Systems Thinking WORKSHOP, Drama Rehearsal Room, September 12, 2024, 13:30 - 15:00

Biography:

Gemma Smith:

As a PhD student in Systems Science with an MSc in Environmental Management, Change and Monitoring, and a Bachelor of Law, I have developed interdisciplinary research interests in marine, coastal, and estuarine management. My educational background provides a foundation for my current role as a research assistant working on Horizon Europe Projects for Marine management; contributing to the research in creating a systems approach to managing complex social-ecological systems within aquatic contexts. Also, I am the Secretary of the ST-SIG Committee as of March 2024.

Combining my legal knowledge with environmental management expertise and systems science, I aim to contribute to the development of holistic and sustainable strategies for environmental management. I strive to advance our understanding of the relationships between human activities and ecological health.

Christian Heathcote-Elliott:

After completing undergraduate and postgraduate qualifications in psychology and working on health-related research projects, I have spent two decades in the NHS within public health intelligence and health improvement. I moved to Wales in 2006 as a health promotion specialist and principal public health practitioner, gaining experience in offender health, substance misuse, obesity, tobacco control, healthy urban planning, and healthcare public health.

Joining Public Health Wales in 2016 as the national principal lead for tobacco control, I provided system leadership for developing and implementing Help Me Quit – Wales' NHS smoking cessation system. Since 2020, I have worked in the Wider Determinants of Health Unit on the causes of ill-health, currently, I provide oversight for a programme taking a systems approach to influencing wider determinants of health within local public sector partnerships.

My interests are understanding and managing complex public health challenges using systems thinking and behavioural science. I recently completed a PG Certificate in Systems Thinking in Practice and joined the ST-SIG Committee in March 2024.

Join us for an engaging and interactive workshop aimed at shaping the future of the OR Systems Thinking Special Interest Group (SIG). This session will bring together SIG members and interested individuals to explore how systems thinking can be applied within the field of OR and to collectively map out the SIG's path forward. The workshop will begin with an icebreaker question, followed by a round of introductions where participants will share their names, institutions, and responses to the icebreaker. The SIG committee will then provide an overview of the group's activities and opportunities for involvement. The main portion of the workshop will feature three creative systems thinking exercises. First, participants will collaborate on a rich picture exercise to identify potential applications of systems thinking within OR. Secondly, they will develop a vision statement using PQR from Soft Systems Methodology. Finally, they will engage in a backcasting activity to propose practical steps to achieve this vision. To conclude the session, each group will share their vision statement and steps to reach the vision, and a poll will be conducted to determine the most popular vision among the participants. This workshop offers a unique opportunity to strengthen connections among SIG members, promote cross-SIG collaboration, and collectively explore how the OR Systems Thinking SIG can serve its community.

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Distinctions as Metacognitive Choices in Systems Thinking

Dr Natalie Clewley, Mr Aydin Asena, Dr Tim Forsyth

Cranfield University

Parallel 9 - Systems Thinking, LR3, September 12, 2024, 13:30 - 15:00

Biography:

Natalie's research interests are at the human-machine interface and are focused on how machine technologies, like Artificial Intelligence or Data Mining, and human thinking tools, like Systems Thinking, influence the way humans and machines work together to make decisions in highly complex environments. She works within an interdisciplinary team that combines cognitive psychology, systems thinking, computer science and artificial intelligence across a number of domains, such as Defence and Security, Cyber Security, Finance, Organisational Resilience and Public Health. She currently teaches on the Systems Thinking Practice L7 MSc/Apprenticeship. Perception and interpretation are simultaneous (Ahrens, 2017). Distinctions, while they are actually interpretations, not perceptions, are made instantaneously as we approach problem solving in complex systems. We feel that they are part of perception and so we mistake them for perceptions of the real world. This promotes the need to work with distinctions as thinking tools, not as reflexive interpretations of the world, or grist for the reflective mill when, in some ways, it is too late. We present an approach for a structured way of thinking as a way of exercising conscious, deliberate choice over how we make distinctions.

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Developing a shared understanding as a foundation for collaborative thinking.

Dr Lorraine Dodd, Jeremy Hilton¹, Dr Natalie Clewley, Dr Tim Forsyth

¹Cranfield University

Parallel 9 - Systems Thinking, LR3, September 12, 2024, 13:30 - 15:00

Biography:

Jeremy Hilton is a Senior Lecturer in Complex Systems at Cranfield University where he designed and teaches on the Systems Thinking Practice Apprenticeship Programme. He is a PI on the UKPRP-funded GroundsWell research Programme on the use of Urban Green and Blue Spaces to improve population health, leading the systems work package.

Common concerns when applying systems thinking to support system design, problem resolution and social change are the context of the problematic situation, the multiple perspectives present and boundary considerations. This is relevant to any of the ontological perspectives and are specific considerations when planning interventions with multiple methods (Jackson, 2006, 2020; Midgley, 2000).

When undertaking a collaborative intervention, the starting point should be the surfacing of these concerns and ensuring all participants have a voice. This is important to provide a foundation for co-creation and collaboration, whilst allowing for a multiplicity of views to be shared. Particularly, when deriving factors for Causal Loop Modelling and Agent-Based Models, Group Model-Building workshops are significantly more effective following the development of a shared understanding. Through dialogue, a consensus on the problematical situation to be addressed, and acknowledgement of the relevant perspectives and an agreed boundary can be achieved. As Spencer-Brown writes “A distinction is drawn by arranging a boundary with separate sides so that a point on one side cannot reach the other side without crossing the boundary. [. . .] Once a distinction is drawn, the spaces, states, or contents on each side of the boundary, being distinct, can be indicated.” (Spencer-Brown, 1969, p. 1). And ‘naming a system implies distinguishing it from its background’ (Espejo & Reyes, 2011).

We have applied a set of systemic tools, within a world café construct, with which to capture these concerns and support achieving a consensus. These include rich pictures (Checkland & Scholes, 1990), cognitive maps (Eden, 1988), context diagrams (Flood & Carson, 1993), multi-perspective diagrams (Morgan, 1993), 6 questions (Hilton & Dodd, 2020) and laddering (Isaksen et al., 2011). These have been successfully applied in major research projects and by our apprentices in significant corporate interventions.

References:

Available on request (exceeds word count)

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People and Organisations – balancing and aligning capabilities with demands and responsibilities

Dr Tim Forsyth, Jeremy Hilton, Dr Lorraine Dodd

Cranfield University

Parallel 9 - Systems Thinking, LR3, September 12, 2024, 13:30 - 15:00

Biography:

Tim serves a dual role in the Complex Systems Governance Group at Cranfield University as a Lecturer in Sociotechnical Systems and the Deputy Course Director for the Level 7 Systems Thinking Practice Apprenticeship and MSc. Having navigated an unconventional career path, which includes a Bachelor of Engineering Degree and a Social Science PhD. Tim's research focuses on 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. His principal research interests lie at the interface of sociotechnical systems and peoples’

subjective experience of challenge in complex organisational environments. His recent research activities have included the design and development of a national research network, using soft methodologies to bring together academia, industry, and government.

The cost of stress (pressures, demands, responsibilities) and the ways stress makes people vulnerable to illness is not just a notion but a well-documented reality (Csikszentmihalyi, 2000; Sapolsky, 2004; Stamp, 1989). This understanding is critical in the domain of Systems Thinking, as it sheds light on the complex dynamics of workplace well-being. The Health and Safety Executive (2019) assert the decline in employee health and well-being is directly attributed to the excessive demands placed on employees by organisations. In other words, people at work are experiencing excessive and unhealthy levels of stress.

Therefore, understanding a person's relationship with pressures, demands, and responsibilities (challenges) becomes imperative to designing sociotechnical systems that directly consider people's subjective experiences and the ways that organisational structures, leadership and governance can directly enable people to thrive and flourish. This research provides valuable insights that can be applied in real-world scenarios to enhance workplace well-being.

Traditionally, research has heavily relied on correlational self-reporting methods to gauge individuals' subjective experiences in relation to their capabilities. However, this study pioneers a new path by adopting a quasi-experimental approach in a naturalistic setting, using explicit dependent and independent variables to gain a deeper understanding of subjective experiences. This innovative approach opens up new avenues for research in the field.

Two significant findings of this study are that 1) people's subjective experience is an emergent phenomenon of the complex coupling between a person's capability and the challenges they experience, and 2) challenges are cumulative and iterative, and that cumulative and iterative challenges can produce nonlinear discontinuous shifts in people's subjective experience.

Tourism & Hospitality

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Forecasting tourism demand recovery from COVID-19: A time-varying parameter approach

Professor Haiyan Song

Research Centre for Digital Transformation of Tourism, The Hong Kong Polytechnic University
Parallel 4 - Tourism & Hospitality KEYNOTE, Drama Rehearsal Room, September 11, 2024, 09:00 - 10:30

Biography:

Professor Haiyan Song is Mr and Mrs Chan Chak Fu Professor in International Tourism in the School of Hotel and Tourism Management and Director of Research Centre for Digital Transformation of Tourism at The Hong Kong Polytechnic University. His research interests are in tourism and hospitality economics with particular focuses on tourism demand modelling and forecasting, consumer behaviour research, and tourism supply chain management. He has played significant roles in a number of international collaborative research projects, covering tourist satisfaction and service quality indices, tourism demand forecasts, web-based tourism demand forecasting systems, and tourist satellite account development. Prof. Song has published more than 250 journal articles in both mainstream economics journals as well tourism hospitality journals such as Journal of Development Economics, International Journal of Forecasting, Economic Modelling, Applied Economics, Journal of Applied Econometrics, Annals of Tourism Research, Tourism Management, and Journal of Travel Research, International Journal of Hospitality Management, and International Journal of Contemporary Hospitality Management

Professor Song is a Fellow of the International Academy for the Study of Tourism (IAST). The honours he received include the John Wiley & Sons Lifetime Research Achievement Award and Lifetime Research Achievement Award by the International Council on Hotel, Restaurant and Institutional Education in 2010 and 2023, respectively. He also received the Michael D. Olsen Research Achievement Award by University of Delaware in 2014. Professor Song was also awarded Honorary Fellow of Council of Australia Universities in Tourism and Hospitality Education in 2019.

The uncertainties associated with the COVID-19 pandemic significantly reduce the accuracy of traditional econometric models in forecasting tourism demand, as the relationship between tourism demand and its determinants during the crisis changes over time. To address these inaccuracies, we apply three Factor Mixed Data Sampling (MIDAS) models with different time-varying parameter (TVP) settings: Factor TVP-MIDAS, Factor MIDAS with stochastic volatility (Factor MIDAS-SV) and Factor TVP-MIDAS-SV. We explore the dynamic relationship between tourism demand and its influencing factors, capture the uncertainty and volatility in the data, and

provide short-term forecasting and nowcasting. We subject the Factor MIDAS models with TVP specifications to different combinations of determinants to examine their performance. The empirical results demonstrate that the Factor MIDAS models with TVP settings show superior performance compared with the Factor MIDAS model in the short-term forecasting and nowcasting of tourism demand during COVID-19. The results also suggest that high-frequency data complement these Factor MIDAS models with TVP settings in improving the forecasting and nowcasting accuracy during crises.

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Advancing Smart Tourism Destinations: High-Resolution Data in Tourism Demand Forecasting

Mr Mitchell Horrocks¹, Dr Adrian Gepp^{2,1}, Dr James Todd¹, Dr Bruce Vanstone^{2,1}

¹Bond University, ²Bangor University

Parallel 4 - Tourism & Hospitality KEYNOTE, Drama Rehearsal Room, September 11, 2024, 09:00 - 10:30

Biography:

Mitchell Horrocks is PhD Candidate in the Bond Business School at Bond University. Mitchell's primary research area is the investigation of mobility and expenditure to gain a greater understanding of tourism and visitor markets using data science. In particular, he is interested in applying both traditional statistical learning and machine learning techniques to better understand these dynamics and provide insights for smart cities, government and businesses.

Technological advancements are transforming city operations and urban planning. The need for timely and accurate tourism data has never been more critical, as highlighted by the challenges faced during the COVID-19 pandemic. Despite advances in big data, applications of tourism demand forecasting in the literature have been slow to adapt to a data-rich world. Traditional methods in tourism demand forecasting often rely on lagged survey data analysed at quarterly or annual intervals. This research introduces a novel framework for hourly, segment-based tourism demand forecasting at the suburb level across a destination. This approach leverages of spatiotemporal mobile phone data collected through a telecommunications network over a four year period. This work is made possible through a collaborative agreement with the City of Gold Coast, and highlights the potential for smart cities to harness big data for urban planning and tourism management. Our study employs both local statistical time-series models and global neural network techniques to evaluate forecasting performance, aiming to bridge the gap between complex modelling techniques with their practical application. We discuss some practical forecasting challenges and data science considerations pertinent to high-frequency tourism data usage including addressing complex seasonality, multi-step forecasting, and performance monitoring and model updating to combat concept drift. This study focuses on the role of data science in transitioning from traditional forecasting approaches to meet the demands of the big data era within smart cities. This research appeals to a broad audience, from forecasters and

tourism academics to industry practitioners, all of whom benefit from deeper insights and actionable intelligence in a rapidly evolving landscape.

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Dynamic Connectedness and Directional Volatility Spillovers from UK Tourism Markets to Financial Markets

Ms Yujia Chang, Professor Mario Brito, Dr. Heather He
1University Of Southampton

Poster Presentations, The Eric Sunderland LT, September 11, 2024, 11:00 - 12:00

Biography:

Yujia Chang holds a Doctor of Philosophy (Ph.D.) in Decision Analytics and Risks from the University of Southampton (2019-2024), where she developed various probabilistic approaches for central banking prediction optimization studies.

Transmission of price shocks across markets has been extensively explored in economic literature. Previous studies, as indicated by Jebali et al. (2014), primarily focused on the relationship between financial and energy markets, while other markets received limited attention. However, the recent global crisis triggered by COVID-19 has brought the tourism industry into sharp focus, with travel restrictions and border shutdowns worldwide.

Tourism is not only a significant service activity but also a crucial driver of trade and economic growth. It rivals, and in some cases exceeds, exports such as oil, food, or automobiles. According to the World Travel and Tourism Council (WTTC, 2019), tourism is among the largest economic sectors globally, creating jobs, driving exports, and fostering prosperity worldwide.

In a broader economic context, tourism interacts with various sectors, contributing to a general equilibrium setting. This paper aims to investigate the volatility transmission of the tourism market to other market indices, providing insights into volatility behavior and connectedness across markets.

Drawing on the approach by Diebold and Yilmaz (2009), which introduces a volatility spillover measure based on forecast error variance decompositions from vector autoregressions (VARs), we aim to measure spillovers in returns or return volatilities across individual assets, portfolios, and markets, both within and across countries. This approach reveals spillover trends, cycles, bursts, etc., conveying useful information about market interconnections. Additionally, we will leverage the framework developed by Diebold and Yilmaz (2012), which explicitly includes directional volatility spillovers, to enhance our analysis.

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The Challenges of SMEs in Smart Tourism Ecosystems

Miss Stefania Escobar¹, Dr Linda Osti^{1,2}, Dr Paola Rovelli¹

¹Free University Of Bozen-Bolzano, ²Bangor University

Parallel 7 - Tourism and Hospitality, LR4, September 12, 2024, 09:00 - 10:30

Biography:

Stefania Denise Escobar is a Research Assistant and Doctoral Candidate in Economics and Management at the Free University of Bozen-Bolzano. She was a visiting research scholar at Free University of Brussels (ULB), New York University (USA), and University of Aveiro (Portugal). Her research lies at the intersection of public management, smart cities, tourism and sustainability. Her research has been presented at TTRA, APAC-CHRIE, SSPCR EURAC, and 3rd World Conference on Smart Destinations. Her work has appeared in the journal *Cities*, *Current Issues in Tourism* and *International Journal of Public Sector Management*.

The evolution of Information and Communication Technologies (ICTs) has brought about profound transformations in the tourism sector (Buhalis, 2020) being indispensable tools at both micro and macro levels of operation. At the micro level, they are pivotal in revenue optimization, customer satisfaction, employee productivity, and operational cost decrease (Yang et al., 2021; Buhalis, 2020). On a macro level, ICTs can foster integration among various stakeholders of the tourism value chain, promoting collaboration and enriching the overall tourism experience and competitiveness, which is why tourism enterprises have increasingly turned to ICT tools (Soares et al., 2022). Consequently, the concept of smart tourism ecosystem was introduced.

Smart tourism ecosystems are defined as those tourism systems that take advantage of technologies to manage and deliver intelligent touristic services/experiences, all of which are characterized by intensive information sharing and value co-creation (Gretzel et al., 2015). Although the introduction of ICTs should benefit all stakeholders in the ecosystem, larger companies and mega-companies are benefitting more widely from new technological developments. The presence of OTAs and social media platforms that leverage ICTs aggravates instead pressure on small and medium-sized enterprises (SMEs). Representing the backbone of the tourism sector (Dredge et al., 2019), it is therefore crucial to investigate how SMEs can survive in smart tourism ecosystems to enhance the sustainable growth of both SMEs and destinations. To this end, this study aims to answer the following research question: What are the most critical challenges for SMEs in smart tourism ecosystems?

This research project entails first defining challenges for SMEs operating in a smart tourism ecosystem based on previous literature. Second, these challenges will be validated and integrated by a group of experts (i.e., tourism SMEs business owners) through semi-structure expert interviews. Finally, the third step will use a multi-criteria decision-making method (MCDM) – specifically, the best-worst method (BWM) – to develop a ranking of criteria, highlighting the most

important (or the best) and less important (the worst) ones in alternative comparable scenarios and unveiling their interrelations (Rezaei, 2015, 2016).

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Determining the most critical challenges to the implementation of a tourist levy scenario for Wales through the Best-Worst Method and Interpretive Structural Modelling

Dr Rhys ap Gwilym¹, Dr Linda Osti¹, Miss Stefania Escobar²

¹Bangor University, ²Free University of Bozen-Bolzano

Parallel 7 - Tourism and Hospitality, LR4, September 12, 2024, 09:00 - 10:30

Biography:

Dr Rhys ap Gwilym is a Senior Lecturer in Economics at Bangor University's Business School. His research interests span public finance, regional economic development, macroeconomics and financial economics.

Tourism represents a tool for economic development and is utilized by most tourist destinations to generate income, employment, and foreign earnings. Nonetheless, tourism brings with it a number of side effects, and when these entail costs, they constitute negative externalities (Sheng et al., 2017). To internalize negative externalities and to collect extra revenue for investments, infrastructure, and social services, over the past three decades, a growing number of governments around the world have imposed tourist taxes (Aguiló et al., 2005; Ihalanayake, 2013).

The Welsh Government has outlined proposals to follow the steps of other countries and provide local authorities with the power to introduce a discretionary visitor levy by 2026 (Welsh Government, 2023). Wales is not the first state, country, or destination to introduce a visitor levy, and it is not the only one to face discontent and obstruction to its plans. It is therefore important for the Welsh Government to understand which factors should be prioritized for the levy to be accepted.

The Best-Worst Method (BWM) and Interpretive Structural Modeling (ISM) are used to evaluate the most critical factors for the acceptance of the levy and to guide the Welsh Government in raising awareness of the relevance of the levy.

Factors will be derived from a literature review based on general taxation papers integrated with the results of the Welsh Government consultation on the proposed visitor levy. The factors identified through review will be included in a questionnaire distributed to tourism experts and key stakeholders. Data from the questionnaire will feed both BWM and ISM.

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Building a Global Risk Index from Tourism

Professor Christopher Gaffney, Miss Stefania Escobar

New York University

Parallel 7 - Tourism and Hospitality, LR4, September 12, 2024, 09:00 - 10:30

Biography:

Christopher Gaffney is a Clinical Associate Professor in the Tisch Center for Hospitality in the School of Professional Studies at New York University. A Vermont-born, Texas-trained geographer, Gaffney has taught in Taiwan, Brazil, Switzerland, and at several universities in the United States. His earlier work focused on the intersection of urban studies and sports mega-events. Gaffney's 2008 monograph, *Temples of the Earthbound Gods*, explored the interdigitation of urban development and sporting cultures in Buenos Aires and Rio de Janeiro.

Fluent in Spanish and Portuguese, Gaffney served as Editor-in-Chief of the *Journal of Latin American Geography* from 2014-2018, guiding the journal's award-winning transformation. Gaffney has appeared in a slew of documentary films and is often quoted in the world's leading media outlets. Gaffney ran an influential blog in the lead up to the 2016 Olympics, *Hunting White Elephants*, and has written extensively on the impacts and realpolitik of sports mega-events across numerous formats. Prior to joining NYU in 2018, Gaffney was the Project Manager for Team Rubicon's disaster relief efforts in post-Maria Puerto Rico.

Currently, Gaffney is working on three streams of research: Global Tourism Risk, Regenerative Tourism Design, and Global Nomadism.

To overcome the negative externalities of tourism development (e.g. social inequality, environmental and cultural degradation), recent studies advocate the need for a tourism reset: a managerial transformation of the tourism system to avoid perpetuating tourism development strategies that ignore the effects of tourism on host community resources and wellness. (Higgins-Desbiolles, 2020; Sigala, 2020; Cheer et al., 2021).

This managerial transformation could begin by turning a tourism system from reactive to proactive in terms of its managing risks (Ivars-Baidal et al., 2023; Ritchie and Jiang, 2019; McLoughlin et al., 2018). However, previous research on the externalities of tourism systems has encountered difficulties in applying macro-level frameworks to micro-level case studies (Cahyanto & Pennington-Gray, 2017; Ritchie and Jiang, 2019). Similarly, sustainability-focused managerial approaches are unable to articulate multi-scalar analysis and are susceptible to greenwashing and the further hollowing out of sustainability.

Therefore, more research is needed that focuses on conceptual and theoretical model building as well as empirical case-study testing to offer an integrated, nested-doll approach to tourism

research that allows for multiple foci around a singular theme, tourism risk (Ritchie and Jiang, 2019).

This research answers the following question: How can risk from tourism activities to host communities be comprehensively assessed from the macro to the micro levels of analysis?

To this end, this research presents the Global Risk Index from Tourism (GRIT), an index of indices whose primary objective is to assess and operationalize risk from tourism at different scales, from the global to the local. We proceed by creating a data matrix organized around four analytic pillars: economic, political, environmental, social. Each of these pillars is populated by indices that we leverage as risk proxies. The analysis is developed at macro, regional and community level and for each level we gather different data and employ scale-specific methodologies.

As a primary outcome, the integrated analysis offered by the GRIT provides a comprehensive understanding of risk from tourism that allows for the development of evidence-based policy recommendations developed in conjunction with stakeholders that operate at diverse scales.

Key Terms: Tourism Risk, nested-doll approach, Risk Index, evidence-based policy

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Forecasting domestic tourism across three different destinations through MIDAS regressions

Consuelo Nava, Dr Linda Osti, Maria Grazia Zoia

University of Aosta Valley

Parallel 8 Tourism & Hospitality, LR5, September 12, 2024, 11:00 - 12:30

Biography:

I'm an Associate Professor of Economic Statistics at the University of Valle d'Aosta. My research interests include applied econometrics, time series analysis, and forecasting techniques, focusing on their applications in regional economics and tourism studies within a Bayesian framework. I hold a Ph.D. in Applied Mathematics and Statistics from the Vilfredo Pareto PhD school at the University of Turin (Italy).

Till the worldwide lockdowns due to the COVID-19 pandemic, international tourism was acknowledged as one of the main economic activities representing a key component in export diversification capable of reducing trade deficits and compensating weaker exports of other goods and services (UNWTO, 2021). Consequently, similarly to most countries in the advanced economies, Italy has posed minimal focus on domestic tourism (DT). Nevertheless, worldwide domestic tourism in 2017 represented 73% of the total global tourism spending. China, the USA, and Germany were the first three countries in the world for travel and tourism domestic spending, and Italy ranked 7th (WTTC, 2018).

The economic super-shock represented by the COVID-19 pandemic unprecedentedly impacted travel, hospitality, and tourism worldwide. International movements for leisure purposes came to a stop for more than 18 months, except for some corridors (or bubbles) that were bilaterally created between countries (as, for example, Australia and New Zealand) or some temporary lifting of travel restrictions during the summer months.

With domestic traveling being the only form of tourism to be allowed for almost two years from 2020 to part of 2022, the purpose of this paper is to propose MIDAS (mixed data-sampling) regressions as suitable forecasting tools to forecast domestic tourism indicators (DTIs), such as domestic expenditures (DTE), arrivals (DA) and overnights stays (DOS), across different Italian regions and sub-regions in a time of crisis, and, in specific, when governmental incentives are introduced. MIDAS models are proposed as they effectively combine data sampled at mixed frequencies, such as financial and (macro)economic variables (see, among others, Ghysels et al., 2007).

This study first analyzed all the Italian regions. Then, it moved to specific municipalities (in South Tyrol) to focus on three distinct holiday destinations: a mountain, a lake, and an urban destination. MIDAS models allowed a combined use of economic and financial variables to estimate and predict DTIs. Using a rich information set reduces uncertainty in the DTIs nowcast/forecast. MIDAS models have also been suitable for capturing the differences between the three types of destinations.

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Exploring destination image attributes with repertory grids: the case of the UNESCO World Heritage Sites in North Wales.

Dr Sonya Hanna, Dr Sara Parry, Dr Linda Osti
Bangor University

Parallel 8 Tourism & Hospitality, LR5, September 12, 2024, 11:00 - 12:30

Biography:

Dr Sonya Hanna is a Lecturer in Marketing at Bangor Business School. She sits on the management board for the 'Places of Climate Change' (PloCC) Research Centre at the University, is an editorial board member for the Journal of Place Management and Development, and a member of the scientific committee for the International Place Branding Association (IPBA). Her research is place focused considering aspects of the place branding process from various perspectives, but more recently looking at sustainability, sustainable tourism, and places and climate change.

North Wales (NW) is an established tourist area generating an estimated £1.8bn for the economy per year (North Wales Tourism, 2024). There are three UNESCO World Heritage sites (WHS) in the region; the Castles and Town Walls of King Edward I in Gwynedd, the Pontcysyllte Aqueduct in

Llangollen and Canal and the Slate Landscape of Northwest Wales (Visit Wales, 2023). With such accolade, Visit Wales launched an inter-national campaign to attract tourists to NW (Daily Post, 2022). The region has continued to attract large tourist numbers due to the rise in staycations and the popularity of adventure holidays, leading to concerns around 'over-tourism' (BBC News, 2021).

This project adopts a business/organisational perspective of all UNESCO WHS across NW to explore their influence on the region's image and the local economy. While research into visitors and resident's perspectives of destinations has gathered momentum (Wang et al., 2021; Afshardoost and Eshaghi, 2020; Akroush et al., 2016), there is a lack of research into destination image from an organisational perspective and none that considers the tourism destination context of NW.

The study adopted a two-stage mixed methods approach consisting of (1) a series of semi-structured interviews (25 professionals/experts across public, private and third sector businesses and organisations), and (2) adopting the Repertory Grid Method (Eden and Jones, 1984), we randomly shuffled NW destinations, as identified by Visit Wales, in triads and asked our interviewees to express bi-polar attributes. Consequently, we created a repertory grid that was distributed online.

We have identified several bi-polar attributes including industrial past/natural landscape, rural picturesque/candy floss belt, costal/rural, community oriented/tourism orientated, Welsh/English, built for tourists/organically evolved, stagnant/evolving, stay put/adventurer visitor, and upper middle class/working lower class visitor economy. We are now distributing the repertory grid and will conduct a PCA to identify main components.

The findings are aimed at the tourism sector to help align their destination development strategies with the identity of the place.

Reference list available if required.

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Decision support for airfare forecasting using an evolutionary approach: Evidence on search engine data from Touristic agency.

Dr Chrysovalantis Vasilakis, Prof George Dounias

Bangor University

Parallel 8 Tourism & Hospitality, LR5, September 12, 2024, 11:00 - 12:30

Biography:

Dr. Chrysovalantis (Valantis) Vasilakis is an Associate Professor at Bangor University, where he also serves as the Director of the Forecasting Lab. He obtained his Ph.D. in Economics and

Management from Universite Catholique de Louvain and holds a diverse academic background with degrees in Mathematics, Economics, and Finance from various institutions including the University of Athens, University of Sheffield, and University of York.

Dr. Vasilakis' research interests span across several domains including International Migration, Applied Econometrics, Human Capital Formation, Finance, Health, Education, Machine learning and Sports. He has contributed significantly to academic literature with numerous publications in esteemed journals such as the European Journal of Operation Research, Journal of Operation Society, Journal of Economic Geography, and Research Policy, among others.

In addition to his academic appointments, Dr. Vasilakis is actively involved in various research affiliations including being a Research Associate at IZA in Bonn, Germany, and a Fellow in Higher Education Academy. He has also held past positions at institutions such as the University of Warwick and Universite Catholique de Louvain.

Dr. Vasilakis' scholarly contributions extend beyond traditional academic research, as evidenced by his involvement in analytics and innovation projects. He has co-authored papers on forecasting during the COVID-19 pandemic and operational research, demonstrating a commitment to applying rigorous analytical methods to address real-world challenges.

This study addresses the complex issue of airfare pricing that influences decisions in the Airline Industry. Our approach involves an evolutionary methodology, combining statistical analysis and symbolic regression through grammar-guided genetic programming models. This innovative method aids internet users/clients in determining optimal periods to purchase fixed-date flight tickets. Data analysis identifies key relations, guiding effective data pre-processing. Results, based on novel data from the search engine of a large European Travel Online agency, cover one and a half years and millions of airfare search cases for seven travel destinations. Benchmarking against last year's price variation, our forecasting accuracy ranges between 80-90% for the tested travel destinations.

Transportation

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On the dynamic dial-a-ride

Professor Rym M'Hallah

Parallel 1 Transportation, G1 Main Arts, September 10, 2024, 10:30 - 12:00

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. The Dial-A-Ride Problem with time windows (DARPTW) designs pick-up and drop off routes of a fixed set of customers with the objective of minimizing travel costs while satisfying drivers' and customers' constraints related to travel duration, total driving time, and both pick up and drop off time windows. This NP hard problem is further complicated when demand arises dynamically over time. For this complex case, we illustrate the impact of the spatial temporal demand and of the time windows on the service performance: number of requests accepted, total cost and occupancy ratio.

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Choice-based availability controls for urban carsharing revenue management

Dr Richlove Frimpong, Professor Rym M'Hallah, Professor Julia Bennell, Professor Christine Currie

Parallel 1 Transportation, G1 Main Arts, September 10, 2024, 10:30 - 12:00

Biography:

Richlove Frimpong is a research associate on the ADROIT team with the role of developing the optimisation algorithms for the EPSRC project Analytics for Demand Responsive Online Intelligent Transport. Richlove focused on the development of a choice-based revenue management methodology for an urban carsharing network which implemented user-based relocation strategies during her PhD degree at Loughborough University. Her current research interests include large scale optimisation techniques, choice modelling, revenue management and pricing with primary applications to the transportation sector. She also holds an Msc in Operations Research and Management Science from Lancaster University and a BSc in Electrical/Electronics Engineering from Kwame Nkrumah University of Science and Technology in Ghana.

Urban carsharing schemes provide flexible, affordable and green mobility services where customers can pick up a car from one station and return it to the same station (round trip) or any other station in the car-sharing network (one-way). While one-way car-sharing service offers a higher degree of mobility flexibility to customers, it may cause operational challenges such as fleet unbalance between multiple rental outlets and increased management costs. Due to this, carsharing operators employ various vehicle relocation techniques to ensure the availability of sufficient vehicles across rental stations. In this study, we adopt the user-based relocation strategy where customers are offered incentives such as fare discounts to drop off the vehicles in proposed alternative destinations. A multinomial logit choice model is proposed to describe customers' purchasing behaviour towards alternative offers. We then formulate a dynamic program (DP) model based on this choice model to determine the optimal destination-fare discount combinations to offer which maximizes the total expected revenue given a customer's booking request. To address the intractability of the DP, we propose two approximation approaches using a choice-based deterministic linear program (CDLP) and a decomposition method (DCOMP). The effectiveness and performance of these three modelling approaches are tested in an extensive numerical study.

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The Shared Car Relocation Problem: An Effective Two-Stage Stochastic Programming Formulation

Mr Mehmet Erdogan, Professor Rym M'Hallah

Parallel 1 Transportation, G1 Main Arts, September 10, 2024, 10:30 - 12:00

Biography:

Mehmet is a PhD Student at KCL Engineering, working on vehicle routing with applications to car sharing.

We consider the dynamic shared car balancing problem in a one-way flexible system. First, we formulate the problem as a multi-period mixed-integer linear program that decides, for each time period, the inventory levels of cars and staff in each station, the number of cars to be relocated between each pair of stations, and the staff assigned for relocation of cars between each pair of stations to minimize the total cost of relocation and lost demand. This model is difficult to solve for large scale instances even when the demand is assumed deterministic and can be accurately estimated from historic data. We therefore present a two-stage stochastic model that supposes that staff availability is non-constraining. We further develop a simulation model for the problem and use it to assess the results of the two-stage model.

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"Why am I stuck at this (airport, all going well) hotel tonight?" - A critical reflection on airport operations and commercial aviation.Dr Maurizio Tomasella¹, Dylan Walch, Dr Stephen Harwood¹University Of Edinburgh Business School

Parallel 4 - Transportation, Welsh Seminar Room, September 11, 2024, 09:00 - 10:30

Biography:

A Reader in Management Science based at the University of Edinburgh Business School, Maurizio's daily joy is tackling messy operational problems in aviation, with a particular focus on airports. He was previously based at the Mechanical Engineering Department of Politecnico di Milano (2004-2008), and the Institute for Manufacturing of the University of Cambridge Engineering Department (2009-2012). Maurizio is the current editor of IMPACT magazine.

This paper starts out with sharing the story of Archie, a passenger who, just like so many of us, ends up stuck in an hotel due to the cancellation of his evening flight back home. Adopting a Cybersystemic lens, we then make sense of Archie's unwelcome night out only to discover the 'multi-ecosystem' dimension of airport operations and aviation more in general, and the sheer complexity behind their dynamics. Through the same lens, we turn the spotlight on a de-facto global blame game that organisations in aviation play time and again, the effect of which is keeping folks like Archie (and us) without answers as to what really caused their overnight stay away from home. More importantly, we find that this blame game is a major roadblock that keeps airport based organisations from enhancing the quality of the service they deliver to passengers. We conclude by showing how an approach that blends Systems Thinking with 'Factory Physics turned Airport Physics' enables airport operators to analyse the operational performance at their aerodrome, and isolate, from the sea of data they have at their disposal, crucial information on selected pockets of inefficiency and ineffectiveness on which they have more direct control, so that these can be targeted promptly through appropriate problem solving. This is important to the aviation industry because a lot of what airport operators are formally accountable for, they have little to no control of. In another paper at this conference, we present a different approach (based on simheuristics and constraint programming) which, by enabling truly cross-organisational collaborative decision making amongst airport based organisations, helps them to do everything possible for the cancellation of Archie's flight to be avoided, as well as to steer clear of downstream knock-on effects, wherever possible.

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A Sorting heuristic Incorporating Primary and Secondary Criteria for Allocating Slots at Level 3 Coordinated Airports

Miss Theodoti Kerama, Prof Konstantinos G. Zografos, Burak Boyaci

Lancaster University

Parallel 4 - Transportation, Welsh Seminar Room, September 11, 2024, 09:00 - 10:30

Biography:

Theodoti Kerama was awarded an integrated M.Sc. in Applied Mathematics and Physics, from the National and Technical University of Athens, Greece (2019), a M.Sc. in Business Analytics with Distinction from Management School, Lancaster University (2020), and is a last-year PhD student of the project “Mathematical Models and Algorithms for Allocating Scarce Airports Resources” (OR-MASTER project) in Lancaster University. Currently she is a Research Associate in Lancaster University, working for the UNCHAIN project. Her major research interests include Mathematical Modelling, Modelling and Simulation, Operations Research in Transportation, Multiobjective Optimisation, Heuristic Algorithms, and Multi-Criteria Decision Making. Theodoti Kerama has also worked as a Mathematics and Statistics tutor for the MASH team of Lancaster University. She has published 1 conference paper, and presented her research work in 2 conferences.

The World Airport Slot Guidelines (WASG) provide the basis for allocating slots at congested Level 3, coordinated airports. WASG include a set of primary and secondary criteria that determine the priority for satisfying airline requests. In this presentation we propose a sorting heuristic algorithm which incorporates both primary and secondary criteria to allocate series-of-slot requests at Level 3 coordinated airports. We employ indices to assess the importance of each request against the WASG primary and a set of secondary criteria, and we seek to minimize rejected requests and total displacement, taking into account aircraft turnaround time and airport capacity constraints. To ensure operational feasibility of the resulting schedules, we also consider curfew constraints for the origin and destination airports. These constraints guarantee that requests will not be assigned slots at the origin and destination airport that will violate curfew regulations. We report results from the application of the proposed heuristic to a medium-size coordinated airport.

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Multi-stakeholder coordination for turnaround services at airports

Dr. SILVIA PADRON ASTORGA¹, Dr Maurizio Tomasella², MSc Elisa Guardo³, Dr. Daniel Guimarans⁴, Dr. Cemalettin Ozturk⁵

¹TBS Business School, ²University of Edinburgh Business School, ³Southampton Business School, ⁴Amazon, ⁵Munster Technological University

Parallel 4 - Transportation, Welsh Seminar Room, September 11, 2024, 09:00 - 10:30

Biography:

SILVIA PADRON ASTORGA is Associate Professor at TBS Business School (Toulouse, France). Her research is focused on metaheuristics and the hybridisation of optimisation methods with simulation techniques to solve stochastic and complex combinatorial problems in application areas such as transportation, aviation, and supply chain management.

Scheduling and running apron handling services such as fuelling, cleaning, and baggage requires coordination between airlines, airport operators, and third-party handler providers. Conflicting goals and uneven power dynamics often hinder collaboration efforts, affecting the efficiency and operational resilience of the entire apron. This paper explores new schemes for cross-organisational collaboration, with a focus on involving ground handlers who are typically underrepresented. We model and analyze various alternatives to coordinate decision-making in task scheduling, capacity management, resource routing, and related information exchange between organisations. Our analysis addresses the periodic (re)scheduling of aircraft turnaround tasks throughout the day, considering common uncertainties and resource shortages faced by ground handlers. Using a simheuristics approach based on constraint programming we quantitatively evaluate the potential improvements in operational performance for individual handler providers as well as for the broader airport apron. Promising results are obtained when ground handling is given autonomy to manage resource limitations, coupled with the implementation of a closed-loop feedback with a coordinating organisation, to ensure congruence between task schedules and resource routes across the apron.

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Price Optimization for Car Sharing

Professor Christine Currie, Professor Rym M'Hallah, Beatriz Brito Oliveira

University Of Southampton

Parallel 5 - Transportation, Welsh Seminar Room, September 11, 2024, 11:00 - 12:30

Biography:

Christine Currie is a Professor of Operational Research in Mathematical Sciences at the University of Southampton and a member of the Centre for Operational Research, Management Sciences and Information Systems (CORMSIS). She is Editor-in-Chief for the Journal of Simulation and Chair of the OR Society Research Committee. Her research interests include simulation optimization, applications of simulation in health care, optimal pricing and disaster management.

Car sharing, car clubs and short term rentals could support the transition toward net zero by reducing the ownership of private cars. Their success depends on them being financially sustainable to service providers and attractive to end users. Dynamic pricing is one tool for incentivizing users in order to balance supply and demand of vehicles. In this talk, we will present fast methods for optimizing the hourly rental price charged to a car sharing customer, using a continuous time Markov chain model to describe the system. We can reduce to a multi-server queueing model under relatively non-restrictive assumptions and the analytical tractability of the queueing model enables fast optimization to maximize expected hourly revenue for either a single fare system or a system where the fare depends on the number of cars on hire, while accounting for stochasticity in customer arrival times and durations of hire. Simulation optimization can also be used, particularly when other complexities such as time-dependence are accounted for. Optimal pricing strategies will be presented for one-way car sharing for a number of different

operating models. Extensions to one-way car sharing, where cars are dropped off at a different location from where they are picked up will also be discussed.

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A Triple Bottom Line optimization model for assignment and routing of on-demand home services

Dr. Debajyoti Biswas, Laurent Alfandari, Claudia Archetti

University College Dublin

Parallel 5 - Transportation, Welsh Seminar Room, September 11, 2024, 11:00 - 12:30

Biography:

Debajyoti is an Assistant Professor working in the area of operations and analytics at University College Dublin. Debajyoti's research interests encompass application of optimisation methods to on-demand services, industry 4.0 and healthcare problems. He teaches courses for the Bachelors and Masters programs covering topics in Data Analytics. Prior to his academic career, Debajyoti also garnered 4+ years of managerial experience, spanning automotive, apparel, FMCG - Food & Beverages industries in the functions of manufacturing, demand planning, logistics and supply planning.

'On-demand home services' is a fast-growing industry where online platforms match independent service professionals with customers seeking aid for household tasks. In this paper, we study the assignment and routing of service professionals for serving customers of an on-demand home services platform considering the Triple Bottom Line (TBL) criteria for ensuring sustainability in operations. We characterise this as the Home Services Assignment and Routing Problem with the Triple Bottom Line (HSARP-TBL) and implement a Mixed Integer Linear Programming (MILP) model for solving it. We assign service professionals to customers based on their desired time slots and also transport modes for each customer visit by a professional, considering either combinations of public transport or a personal vehicle for each professional's tour. The objective is to minimize costs due to time window violations and uncovered customers, catering to the economic pillar of the TBL. We incorporate additional constraints related to the TBL by improving customer satisfaction based on the ratings of assigned professionals to customers, with and without subscription (economic), controlling emissions due to transportation of professionals (environmental) and ensuring equity in service allocation and net earnings between professionals (social). For tackling large instances we implement a Hybrid Genetic Search (HGS) algorithm adapting it to our problem setting. We demonstrate that the HGS outperforms the MILP model systematically for large instances in terms of solution value and computational time. Finally, we observe that for some instances, without worsening the primary economic objective, all the TBL indicators can be improved.

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A Novel Workforce Scheduling and Routing Problem with Shared Vehicles and Dynamic Drop-off and Pick-up Policies

Dr Omer Ozturkoglu¹, Dr Gokberk Ozsakalli, Prof Vikas Kumar

¹Birmingham City University

Parallel 5 - Transportation, Welsh Seminar Room, September 11, 2024, 11:00 - 12:30

Biography:

Dr Ozturkoglu is an academic in Industrial and Systems Engineering with over 20 years of international teaching, research, and curriculum development experience. He has coordinated and taught various undergraduate and postgraduate modules such as Production & Operations Management, Project Management, Facilities Planning and Design, Distribution Center Design and Operations, and Simulation.

Dr. Ozturkoglu has honed his expertise in the optimization and design of production and logistics systems, with a specific focus on areas such as warehousing, material handling, and routing. Notably, he has successfully secured six external grants, totalling approximately £400,000, serving as either the Principal Investigator or Co-Investigator on these projects.

Furthermore, he has contributed significantly to the academic community through the publication of more than 35 peer-reviewed scientific articles, appearing in various esteemed journals, conferences, and books, including prominent publications such as EJOR, IIE Transactions, and Advanced Sustainable Systems. In addition to his research contributions, Dr. Ozturkoglu has guided and mentored numerous students, supervising the completion of 5 PhD. theses and 50 MSc dissertations. His practical experience extends beyond academia, as he has provided consultancy services to several logistics companies.

This paper introduces a novel extension of the Workforce Scheduling and Routing Problem by incorporating shared vehicles and drop-off and pick-up policies. The objective is to optimize the allocation and routing of workers by allowing vehicle sharing under Dedicated and Flexible drop-off and pick-up policies, thereby improving operational efficiency. We developed Mixed Integer Linear Programming (MILP) models and applied an Adaptive Large Neighborhood Search algorithm tailored to the problem. To evaluate the impact of these policies, we considered factors such as service area, number of customers, and task difficulty of service request. Our findings reveal that implementing Dedicated and Flexible Drop-off and Pick-up policies notably improves operational efficiency and reduces workers' total flow time, by up to 23% and 28%, respectively, compared to shared transportation without drop-off and pick-up practices. This effect is particularly pronounced in urban areas with dense customer populations or when task complexity increases. Additionally, the Flexible policy presents a 49% reduction in total waiting time resulting in up to 5% additional savings on total workers' flow time in comparison to the Dedicated policy. The

break-even analyses presented that the potential cost benefits of adopting vehicle sharing with drop-off and pick-up policies increase as the number of customers increases, the service area decreases, and the difficulty of the service request increases, in comparison to the conventional workforce models with a dedicated vehicle for each worker. This supports the strategic use of vehicle-sharing along with drop-off and pick-up policies, especially in operational environments where vehicle costs are higher than or equal to labor costs.

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Planning for Disruptions: Improving Reliability and Resource Allocation in Public Transport (ReAPT)

Di Nguyen¹, Seyed Omid Hasanpour Jesri¹, Vincent Hargaden¹, Pezhman Ghadimi¹, Heletjé van Staden¹, Alexander Garvey, Giulia Oeschger¹

¹University College Dublin

Parallel 8 - Transportation, G1 Main Arts, September 12, 2024, 11:00 - 12:30

Biography:

Di Nguyen is an Assistant Professor in the School of Mechanical and Materials Engineering, University College Dublin. She works on network interdiction problems with uncertainty and risk considerations.

Transportation accounts for approximately 15% of the global greenhouse gas emissions, according to the United Nation first global stocktake's technical report. Demand interventions, such as encouraging a shift to public transport, are considered essential to mitigate the impact of climate change. However, having reliable, accessible, and affordable public transport remains far from reality for many communities. Our work examines how the lack of reliability – a key determinant of passengers' satisfaction – disincentivizes a modal shift. We also propose technical solutions aimed at enhancing operational readiness to address foreseeable and unforeseeable disruptions in the transport network in making short (reactive), medium, and long-term (proactive) plans. Specifically, the technical solutions can efficiently provide accurate real-time predictions even in non-normal traffic conditions, optimized schedules, and a means to coordinate multiple transport modes in a network. We discuss the implications and opportunities of public transport disruptions within the larger societal context (e.g., gender/socio-economic dimensions), as well as potential research directions to support future transport policies.

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Mathematical programming formulations for the simultaneous battery swapping and repositioning problem in e-scooter sharing systems

Arghavan Sharafi, Dr Esra Koca¹

Sabanci University

Parallel 8 - Transportation, G1 Main Arts, September 12, 2024, 11:00 - 12:30

Biography:

Arghavan Sharafi has been a PhD student in the Industrial Engineering Program at Sabanci University since 2020.

Electric scooter-sharing systems are becoming increasingly popular across the world, as a convenient, environmentally friendly urban transportation option. These systems provide scooters equipped with electric batteries at various stations across cities. Users can take available scooters with sufficiently charged batteries from a station, go on a trip, and then leave them at other stations. Two primary challenges emerge when addressing station demands: ensuring an adequate supply of scooters at stations and guaranteeing that these scooters have sufficiently charged batteries for their intended journeys. To meet user demand effectively, numerous companies employ strategies such as redistributing electric scooters between stations. Another strategy is battery swapping, which entails replacing insufficiently charged batteries with fully charged ones in scooters.

This study addresses the electric scooter rebalancing problem with battery swapping, in which a fleet of identical capacitated vehicles performs redistribution and battery swapping simultaneously to minimize total traveling costs. To the best of our knowledge, this problem is not studied in the literature before. We develop four different mixed-integer linear programming formulations for this problem and compare them through computational experiments.

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A Metaheuristic for the Maximum Coverage Facility Location Problem with Drone

Dr Cagri Koc¹, Mr Yasin Yankaya², Prof Fulya Altiparmak²

¹Social Sciences University of Ankara, ²Gazi University

Parallel 8 - Transportation, G1 Main Arts, September 12, 2024, 11:00 - 12:30

Biography:

Cagri Koc received his Ph.D. degree in Operational Research/Management Science from Southampton Business School, University of Southampton, in 2015. He worked as a postdoctoral Fellow at HEC Montreal and CIRRELT. He is an Associate Professor with the Department of Business Administration, Social Sciences University of Ankara. He is the recipient of the Doctoral Award from the Operational Research Society. He has published 35+ articles in leading academic journals and five book chapters. His research mainly focuses on the application of mathematical formulations and metaheuristic optimization algorithms to transportation and logistics problems. This study addresses the maximum coverage facility location problem with drone which considers the assignment of drones to predetermined facilities considering a set of demands and potential facility locations. The aim is to locate facilities to maximize the demand served by drone. In the problem, the transportation cost is not considered. If a customer demand exceeds the drone

carrying capacity, multiple flights are made to fulfill the demand, and in this case, the number of flights is determined according to the drone capacity. Each drone can complete several one-to-one deliveries until the battery level is finished. The charging of drone batteries, charging cycles, weather conditions and the impact of obstacles such as tall buildings or mountains are not considered. We first model the problem as an integer linear programming formulation. We then develop a hyperheuristic based on adaptive simulated annealing algorithm. The metaheuristic starts with a greedy construction algorithm to generate the initial solution. We enhance the metaheuristic by introducing several problem specific procedures. We conduct extensive computational experiments on diverse size of benchmark instances to deeply analyze the method performance. The effectiveness of the algorithm is evaluated by comparing it with state-of-the-art methods in the literature where we observe that our algorithm outperforms them in terms of both solution time and quality. Our method yields better results up to %8.4 on maximum coverage when compared with the best-known solutions.

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A RAM (Reliability, Availability, Maintenance) -informed safety analysis of the threat path leading to a SPAD (Signal Passed at Danger)

Mr. Fotis Zapantis

Datakind UK, ex-RSSB

Parallel 9 - Transportation, G1 Main Arts, September 12, 2024, 13:30 - 15:00

Biography:

Dedicated and highly skilled Safety Assurance Engineer (RSSB TCTSG) specialised in Systems and Automatic Control with 10 years of experience in designing, implementing, and maintaining complex systems. Comfortable working in a multi-disciplinary setting (Human Factors, Research, Consultants, SMEs, Academia) to assure system safety, reliability and performance. Seeking to leverage my regulatory expertise acquired during my time with the System Safety Directorate at RSSB, collaborating with ORR and Network Rail, to drive technical and safety assurance success in a dynamic organization. Double Masters holder with a merit-based scholarship in Railway Systems Engineering and Integration from U. of Birmingham [MIET ID: 1100328583]

On July 2019, 41 trains passed red signals on Britain's rail network marking a record number in a single month for more than a decade.

By the end of January 2020, the risk from Signals Passed at Danger reached the highest value since June 2011 being almost equal to what it was back in 2006. For a railway network that is considered one of the safest in Europe, this deterioration in safety performance is contrary to the statistics showing that signalling systems are becoming more reliable due to the gradual transfer of control to Railway Operating Centres.

At the same time, increasing centralisation means that signalling failures have a greater impact on train delays because whilst signalling technology has become more resilient, this has been offset by the greater number of trains on the network. According to the Rails Safety and Standards Board, 10 trains in the year leading to 2020 alone reached the conflict point – the position along the track at which a collision could have taken place. We take this baseline and compare it to another railway network, that of Greece, which suffered one of the most fatal train accidents in the country's history on 28 February 2023, by looking at operational, strategic and engineering design parameters that might have had a good influence from an operational design perspective with a focus on point and continuous control systems as well as centralisation versus decentralisation. The report will also attempt to cover tangent issues such as European benchmarking, risk engineering and safety systems in place as well as climate change and adaptation.

A central aim of this paper is to examine the evidence from a forensic engineering perspective, to identify the potential explanations to the adverse trends in performance and to give data-driven recommendations to industry that extend beyond the Safety I perspective and promote collaboration as well as a shared commitment to monitor risk.

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Strategic Coalition Formation in Horizontal Collaboration: Enhancing Trust and Efficiency in Distribution Networks

Dr Mahnaz Hosseinzadeh

University Of Sheffield

Parallel 9 - Transportation, G1 Main Arts, September 12, 2024, 13:30 - 15:00

Biography:

Mahnaz Hosseinzadeh is a Lecturer in Operations Management and Decision Sciences at Sheffield University Management School, University of Sheffield, United Kingdom. She holds a PhD in Operational Research from the University of Tehran. Her research focuses mainly on system dynamics, optimisation, multiple criteria decision making and soft operational research, emphasising social sustainability in supply chains.

This paper introduces a novel bi-objective two-stage robust optimization model designed to enhance horizontal collaboration through coalition configurations among partnering companies sharing distribution centers in network design. The primary focus lies on determining the optimal coalition formation for each distribution center to minimize total costs and maximize trust within the network.

To tackle the complexity of the model, a tailored column-and-constraint generation algorithm is deployed. This method enables the handling of varied collaborative scenarios—from fully

centralized to fully decentralized frameworks—and assesses the impacts of different uncertainty budgets on the network's performance. Through extensive numerical experiments, this study evaluates the effectiveness of the coalition formation mechanism under diverse conditions, including the formation of a grand coalition.

The findings reveal that strategic coalition formation not only reduces costs but also enhances the flexibility of the distribution network. Notably, in scenarios where companies form partnerships across different industries, there is an increased willingness to share information and collaborate, attributed to reduced fears of competitive threats. This openness significantly mitigates concerns about partner opportunism and fosters a more cooperative environment.

Furthermore, the paper explores the dynamics of information asymmetry in distribution-sharing arrangements. It highlights how the host carrier's control over sensitive data can influence the willingness of other carriers to engage in collaborative arrangements, potentially affecting the overall efficacy of the network design.

The results underscore that collaborative approaches consistently outperform non-collaborative ones in terms of operational robustness and cost-effectiveness. The study concludes that diversified collaborative networks are not only more adaptable and scalable but also better positioned to manage collaboration risks effectively, making them a strategic asset in today's volatile market conditions.