



THE
OPERATIONAL
RESEARCH
SOCIETY

ABSTRACTS

SW18 Simulation Conference
19-21 March 2018
Ettington Chase Hotel, UK. CV37 7NZ

Please find below the abstracts for the tutorials, papers, panel sessions and posters being presented at SW18 - (in date and time order)

19/03/2018 : 13:00-14:30 : Wordsworth Room 1

Introduction to Discrete-Event Simulation: How It Works

Stewart Robinson, (*Loughborough University, UK*)

This tutorial paper introduces the two main building blocks of a discrete-event simulation: modelling the progression of time and modelling variability. The three-phase method, which is used by a number of simulation software packages, is described, and there is a brief introduction to other methods for modelling the progression of time. The use of random numbers and random sampling for modelling variability is also outlined.

19/03/2018 : 13:00-14:30 : Wordsworth Room 2

Introduction to Hybrid Simulation Modelling

Sally Brailsford, (*University of Southampton, UK*)

This tutorial paper provides a basic introduction to hybrid (or multi-paradigm) simulation modelling, as understood by an operational researcher. Hybrid simulation is defined as a modelling approach that uses more than one simulation paradigm from the set {discrete event simulation, agent based simulation, system dynamics}. Hybrid simulation has gained popularity in recent years, partly due to the availability of commercial software for developing hybrid models, and partly due to the capability of hybrid models to tackle different aspects of the same problem situation. The session itself will be a hands-on introduction to hybrid simulation modelling in AnyLogic.

19/03/2018 : 15:00-16:30 : Wordsworth Room 1

Verification and Validation (V&V): Doing the Right Thing, It's All about Good Business

Paul Glover and Alan Robinson, (*Defence Science and Technology Laboratory, UK*)

The purpose of this paper and associated workshop is to share perspectives on conducting appropriate V&V for simulation, so as to facilitate the delivery of 'fit for purpose' advice to the customer. This paper provides an overview of UK government advice for achieving this and presents emerging perspectives on how this advice may be enhanced. The purpose of the associated workshop is to briefly summarise the current situation and provide foci for discussion to stimulate sharing as to how this advice could best evolve, for the benefit of simulation in Operational Research (OR).

19/03/2018 : 15:00-16:30 : Wordsworth Room 2

Agent-Based Models Tutorial

Duncan Robertson, (*Loughborough University, UK*)

We introduce agent-based modelling in this tutorial paper. We introduce the concepts of agent, emergent behaviour and show these concepts in three different agent-based models.

19/03/2018 : 17:00-18:30 : Wordsworth Room 1

A Tutorial on Simheuristics: How Simulation can Efficiently Support Metaheuristic Algorithms in Stochastic Optimization

Angel Juan, Laura Calvet and Christine Currie (*Universitat Oberta de Catalunya, Spain and University of Southampton, UK*)

Uncertainty is present in industrial sectors such as transportation and production logistics, supply chain management, computer and telecommunication networks, or economics and finance. Thus, in order to cope with their stochastic components, simulation methods and techniques are frequently employed in the analysis of complex systems related to these sectors. However, simulation is not an optimization tool, so it needs to be combined with optimization methods whenever the goal is to maximize the system performance or to minimize the associated costs. A large number of these real-life optimization problems are NP-hard and large scale in nature, which makes it necessary the use of metaheuristic approaches to solve them in an efficient way. This paper provides an introductory tutorial to simheuristic algorithms, i.e.: the combination of simulation methods with metaheuristics to efficiently deal with stochastic optimization problems. After motivating the need for simheuristics in today's world and reviewing some related work, a series of key methodological and computational aspects are discussed in detail. Then, several examples of application to different industries are provided. The paper also describes open research lines and future trends in this emerging area.

19/03/2018 : 17:00-18:30: Wordsworth Room 2

System Dynamics: A Multi Approach to Simulation

Martin Kunc (*University of Warwick, UK*)

System Dynamics (SD) is a unique modelling approach to simulation because it can be employed for qualitative and quantitative modelling. There are important tools and methods within SD that are able to accommodate qualitative modelling. Stocks and flows are the basic components of quantitative SD modelling but quantitative SD modelling shares many commonalities, e.g. empirically driven, validation and verification, and focus on outputs, with traditional simulation methods. This tutorial offers modellers aspects to consider when they want to use SD as a qualitative and quantitative modelling method.

20/03/2018 : 09:15-10:30 : Wordsworth Room 1

KEYNOTE SPEAKER

Personal Reflections on the Evolution of Simulation over the Last 20 years.

John Fowler (*Arizona State University*)

Simulation has changed considerably over the last three and a half decades and in this paper I will share some of my thoughts on how simulation has evolved during this time. I will touch on the changes in simulation software, simulation practice, simulation research and the reputation of simulation. I will comment on current trends and possible future directions.

20/03/2018 : 11:00-12:00 : Wordsworth Room 1

Identification of the Skills Required for Discrete Event Simulation Project Analysts

Tábata Fernandes Pereira, José Arnaldo Barra Montevechi and Stewart Leslie Robinson,
(*Federal University of Itajubá, Brazil and Loughborough University, UK*)

DES is a useful technique utilized for decision-making, it is helpful due especially the complexity of the systems. DES projects are complex, large, and has lots of data, thus it is important to manage these projects. Considering that a good management can impact for the projects achieve their success, this paper has the objective of performing the identification of the main skills required for an analyst be a good Simulation Project Manager. In order to achieve this objective, a literature review was conducted, some works that present skills on developing DES project were identified. Also, there were some interviews performed with specialists in order to identify the skills in a practical side. After the data collection, it was possible to realize the analysis. As results of the paper, it was possible to define three classifications of skills: personal, management, and technical. Other findings could be highlighted at the end.

An Application of Object-Functional Programming to Simulation Modelling for Defence

Gareth Toomey, Paul Glover and Rick Ansell, (*Defence, Science & Technology Laboratory, UK*)

This paper discusses the Dstl experience of applying the emerging Object-Functional paradigm to simulation modelling for defence and the 'so-what' for analysis. The simulation framework has been named GAMOV, in recognition of the work of Georgiy Antonovich Gamov in making clear explanation of science through his work. Exploitation of the Object-Functional paradigm for the development of GAMOV has resulted in the production of a highly adaptable modelling environment, with the capability to produce problem-focused models that are more efficient to maintain. In the absence of widely accepted design patterns to support those working with this paradigm, strong design skills and discipline are required from those seeking to apply it.

20/03/2018 : 11:00-12:00 : Wordsworth Room 2

Proposal of a Design Pattern for Embedding the Concept of Social Forces in Human Centric Simulation Models

Peer-Olaf Siebers, Yufeng Deng, Jonathan Thaler, Holger Schnädelbach and Ender Özcan,
(*Nottingham University, UK*)

There exist many papers that explain the social force model and its application for modelling pedestrian dynamics. None of these papers, however, explains how to implement the social force model in order to use it for systems simulation studies. In this paper we propose a design pattern (reusable template) that supports the implementation of the social force model within an artificial lab, to run experiments for human centric systems. It allows considering not only people but also static and moveable markups. We demonstrate how to implement the design pattern in two commonly used agent-based modelling packages, Repast Symphony and AnyLogic. For this purpose we use an illustrative example from the Adaptive Architecture domain. Both packages require a slightly different implementation strategy, due to the API constraints they provide. Overall, we found that the design pattern provides very helpful guidance when working on the individual solutions for the different packages.

Input Model Uncertainty Assessment: A Study Within the Automotive Industry

Panagiotis Ioannidis, Bhakti S. S. Onggo, Michael Higgins and John Ladbrook, (*Lancaster University, UK; Trinity Business School, UK and Ford Motor Company, UK*)

Input model uncertainty refers to the uncertainty surrounding the choice of distributions and their parameters, due to the use of finite samples from the population. Input model uncertainty is often not included in the standard output analysis, something that could result in confidence intervals that are too optimistic. This paper discusses how the input model uncertainty in a model used by Ford Motor Company is quantified using mean-variance metamodel approximation. The variance caused by input model uncertainty is deduced and expressed in units of simulation sampling error. The assessment estimates the distributions' contributions to input uncertainty and the sample size sensitivities. The method also entails the construction of a metamodel that relates the means and variances of the distributions included in the assessment, to the means of the simulation output. This metamodel, could be used as a quick stand-in to the model comprising of the distributions included in the assessment.

20/03/2018 : 13:00-14:30 : Wordsworth Room 1

Right Hospital- Right Time: A Business Analytics Framework for Analysing Urgent Care/A&A Wait Time Data

Navonil Mustafee, John H. Powell and Alison Harper, (*University of Exeter, UK*)

Right Hospital – Right Time (RH-RT) is the conceptualisation of the application of descriptive, predictive and prescriptive analytics (including simulation) with Urgent Care/A&E wait time data; its objective is to derive the maximum value from wait time data for the benefit of both patients and the NHS. The paper presents an architecture for the implementation of RH-RT that is specific to the authors' current work on a digital platform that makes available live waiting time data from multiple centres of urgent care (e.g., A&E departments, Minor Injury Units, etc.) in Devon and Cornwall (NHSquicker). The focus of the paper is on the prescriptive analytics component of RH-RT and which could be realised through a Hybrid Systems Model (HSM) comprising of business intelligence, forecasting techniques and computer simulation. The contribution of the paper is the conceptual RH-RT framework and its implementation architecture that relies on near real-time data from NHSquicker.

Bed.P.A.C: A Simulation Model for the Planning of Hospital Beds and Workforce

Tracey England, Tom Stephenson, Paul Harper, John Boulton, Claire Cordeaux and Edward Ostler, (*Cardiff University, SIMUL8 Corporation and ABCi UK*)

Hospital bed management is crucial to ensure that patients do not have to wait for the right bed for their care. SIMUL8 has in the past developed several bed planning models for one off decisions on bed numbers and quarterly/annual planning. From those they created an easy to use tool which could aid hospital planners. From the initial development of their BED.P.A.C long term model through to the recent short-term model, discrete event simulation has proved to be a very useful and accurate approach to assessing the demand on hospital beds. This paper aims to describe each of the existing bed planning models (long term and short term) along with the introduction of workforce planning into the tools. The paper also discusses the one-week feasibility pilot study which examined the accuracy and usability of the short term tool applied to a trauma and orthopaedic bed system.

Effective Provision of Critical Care Services: a Simulation Model

Dandan Shi, Christine S.M. Currie and Honora K. Smith, (*University of Southampton, UK*)

Demand for critical care services is increasing and there is pressure on hospitals to improve the efficiency of delivering the service. Of particular interest in this work is the impact of 'late admissions' to the Intensive Care Unit (ICU). Patients admitted to the ICU more than a day after entering the hospital are shown to have higher mortality rates and to stay longer in the ICU. We describe a Discrete Event Simulation model to investigate the impact of the 'late admission' group and strategies for improving efficiency by bringing patients into the ICU earlier. The DES model is described and validated using data from a UK ICU.

20/03/2018 : 13:00-14:30 : Wordsworth Room 2

Deterministic Simulation and Graphical Representation of Powered Material Handling Vehicle Movements to Enhance Pedestrian Safety

Michael Higgins, Gaurav Khalwadekar and John Ladbrook, (*Ford Motor Company, UK and Caresoft Global, UK*)

A deterministic Material Flow Analysis (MFA) simulation tool has been developed within Microsoft Excel allowing the user to simply and quickly enter relevant material and logistics data. This data is then processed mathematically stepping through time in user-specified intervals assessing stock levels and statuses of vehicles. The monitoring of the material flow in this manner provides data resolution that has not been achievable within Ford prior to the use of simulation. A further extension has been developed enabling effective communication of safety-critical simulation output to be presented diagrammatically as a "Material Flow Heat Map". Preliminary implementation has shown the tool is effective at both confirming expected and highlighting new, high-traffic hotspots in the plant. Through the development and implementation of these methods, the movement of vehicles is better understood allowing targeted engineering actions to improve productivity and enhance pedestrian safety for both existing and proposed future facilities.

Airline Disruption Recovery Using Symbiotic Simulation and Multi-fidelity Modelling

Luke Rhodes-Leader, Bhakti Stephan Onggo, David J. Worthington and Barry L. Nelson, (*Lancaster University and Trinity Business School, UK*)

The airlines industry is prone to disruption due to various causes. Whilst an airline may not be able to control the causes of disruption, it can reduce the impact of a disruptive event, such as a mechanical failure, with its response by revising the schedule. Potential actions include swapping aircraft, delaying flights and cancellations. This paper will present our research into how symbiotic simulation could potentially be used to improve the response to a disruptive event by evaluating potential revised schedules. Due to the large solution space, exhaustive searches are infeasible. Our research is investigating the use of multi-fidelity models to help guide the search of the optimisation algorithm, leading to good solutions being generated within the time constraints of disruption management.

Modelling Refugees Escaping Violent Events: A Feasibility Study from an Input Data Perspective

Nga Ting Chan, Diana Suleimenova, David Bell and Derek Groen, (*Brunel University London, UK*)

Out of many studies on the determinants in driving migration flow, violence has widely been recognized as one of the most important ones. We propose a simulation development approach suitable for refugee population size prediction. Particularly, this paper focuses on model design process from an input data perspective of refugee modelling. We aim to find out

the correlation between the occurrence of violent events and refugee count, and attempts to predict the number of refugees that escape these conflicts. We were unable to find a significant correlation in the source data at this time. This does not mean the assumption that violent event can induce refugee flow should be ruled out completely.

20/03/2018 : 14:30-15:00 : Wordsworth Room 1

POSTER ABSTRACTS x10

Modelling Demand and Capacity at Health Board Level

John Boulton, Tracey England, Izabela Spernaes, Doris Behrens and Daniel Gartner (*ABCi, ABUHB, ABCi; Cardiff University, ABCi*).

In 2012, Aneurin Bevan University Health Board submitted a business case for a new Specialist and Critical Care Centre. The application to Welsh Government was based on a detailed Excel model which considered the number of beds needed, per specialty, based on the average length of stay (LoS) if each specialty achieved a LoS that matches the top 25% performing hospitals. In October 2017, the ABCi Modelling Unit were commissioned to relook at the existing model and develop more robust models, one for the current situation and one for the planned future. This poster shows the resulting discrete event simulation (based on over 608,000 patient episodes) that replaced the two proposed models. The main benefit of the simulation was that it could model the whole healthboard system from A&E to the ward and enable an evaluation of the relationship between bed utilisation and hospital performance (4-hour target) to be conducted.

Validation Challenges with Next Generation Models

Paul Glover (*Dstl*)

Defence is seeking to establish agile collaborative working as the new norm in its approach to simulation. Most of the systems being studied are Complex Adaptive in nature, with key socio-technical elements and the required Validation concerns counter-factual analysis of emergent situations. New approaches to Validation are thus needed in the face of increasingly evolutionary approaches to simulation. These approaches need to encompass appropriate expression of the consequential Uncertainty associated with such modelling.

Part of the challenge is that it is anticipated that some partner organisations may wish to offer 'Black Box' solutions for parts of a simulation. In this regard academic discussion indicates increasing concern about the challenges of meaningful inter-working between differently founded perspectives. The bottom line is to be able to recognise how 'wrong' a simulation model needs to be and in what ways before it no longer produces meaningful insight.

Simulating Alternative Nurse Staffing Strategies

Christina Saville, Peter Griffiths, Tom Monks and Jeremy Jones, (*NIHR CLAHRC Wessex Data Science Hub, (University of Southampton)*).

The Safer Nursing Care Tool (SNCT) is used by many NHS hospitals to set nurse staffing levels. Using this tool involves categorising patients based on their acuity and dependency on nursing care. The patient counts in each category are weighted and summed to obtain the staffing requirement in whole-time-equivalents. The staffing requirement is assessed over a baseline period, then averaged to obtain the number of staff to employ on the ward.

The aim of this simulation study is to test alternative strategies both for setting staffing using the SNCT and for sharing staff between wards. We present a generic hospital simulation where the wards are agents. This simulation model will be parameterised with a years' worth of data from 4 hospitals. Our expected contributions are validation of a widely-used nurse staffing tool and providing guidelines on its use in different ward types.

Detecting Bias Due to Input Modelling in Computer Simulation

Lucy Morgan, Barry Nelson, David Worthington and Andrew Titman (*Lancaster University*), (*Northwestern University*), (*Lancaster University*).

Bias due to input modelling is caused by having only a finite amount of data to estimate the input processes that drive the simulation model. Until now this type of error has been assumed negligible and ignored. This is due to bias due to input modelling decreasing faster than input uncertainty as the amount of real-world data available for modelling increases. However, this does not mean bias is irrelevant when considering the error in a simulation performance measure caused by input modelling.

On this poster we present a response surface approach to bias estimation for a simple tandem queuing model with two unknown inputs. Along with a diagnostic test for identifying, with controlled power, bias due to input modelling of a size that would be concerning to a practitioner.

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The airlines industry is prone to disruption due to various causes. Whilst an airline may not be able to control the causes of disruption, it can reduce the impact of a disruptive event, such as a mechanical failure, with its response by revising the schedule. Potential actions include swapping aircraft, delaying flights and cancellations. This poster will present our research into how symbiotic simulation could potentially be used to improve the response to a disruptive event by evaluating potential revised schedules. Due to the large solution space, exhaustive searches are infeasible. Our research is investigating the use of multi-fidelity models to help guide the search of the optimisation algorithm, leading to good solutions being generated within the time constraints of disruption management.

Performance Assessment Outcome-Based Contract over the Delivery Phase

Emmanuel Musa (*Aston University*).

Previous research have focused on the design and development of outcome-based contracts underpinned by product-service systems. However, more research is required to assess the performance, management and execution of these contracts over its delivery phase. This poster uses discrete- event simulation method to assess the performance of an outcome-based contract offered by a medium-scale enterprise in the west-Midlands. The result is a description of key performance indicators that are essential to the improvement and delivery of outcomes.

Using Case Studies in Health Care to Explore How Conceptual Models Change over Time

Kathy Kotiadis and Thomas Monks (*Canterbury Christ Church University*) and (*NIHR CLAHRC Wessex Methodological Hub*).

It is thought that very few simulation models in Health Care are used consistently over short or long periods of time. In recent years the idea of sustainability in simulation modelling has raised questions about the utility of models beyond the first use to subsequent use over short and longer periods of time. To prolong the utility of simulation models in Health Care we need to address conceptual model development so that it captures future states of the system of interest. One problem with that, is that there are currently no studies in health care to contribute to our understanding of how conceptual models change over short and longer periods of time. The study uses case studies of DES models developed in healthcare spanning over 10 years and shorter timeframes to explore questions such as how long does it take before a simulation model is no longer fit for use.

Simulating Storage Policies for an Automated Grid-Based Warehouse System

Michaela Wissing, Simon Malberg, Kevin Tierney and Christoph Weskamp (*Paderborn University*).

Robotic fulfillment systems are becoming commonplace at warehouses across the world. High-density, grid-based storage systems in particular, such as the AutoStore system, are being used in a variety of contexts, but very little literature exists to guide decision makers in picking the right policies for operating such a system. Storage policies can have a large effect on the efficiency and storage capacity of robotic fulfillment systems. We therefore introduce a discrete event simulation for grid-based storage and examine input storage policies under a couple of storage scenarios. Our simulation provides decision makers with an easy way of testing policies before implementing them in a real system, and shows that selecting the correct policy can lead to up to a 7% input performance improvement, and 60% better box utilization.

An Investigation of Simulation Modelling Techniques for the Appraisal of Medical Devices.

Samuel Omoniyi (*University of Exeter*).

Background: Medical devices are key components of the health technology used for healthcare interventions. Many health technology assessments (HTAs) focus on the particular products in terms of their efficacy, safety and cost-effectiveness. Most HTAs do not provide integrated technology assessment necessary to fully implement relevant decisions. HTA-informed healthcare decisions need to move beyond just providing technical evaluation of a technology to addressing policy issues on the operations management impact and applicability of the technology.

Study Objectives: These include identifying how to integrate pre- and post-launch appraisal of medical devices, and exploring the use of simulation modelling techniques to support decisions on development and operational use.

Methods: This study seeks to investigate how hybrid simulation modelling can be used to appraise medical devices by integrating health technology assessment with operations management.

Expected Contribution: This study is designed to provide decision support for healthcare decision-makers within a hospital setting.

A Hybrid Systems Modelling Approach using Real Time Data and Computer Simulation in Healthcare.

Alison Harper and Nav Mustafee (*University of Exeter*).

Reviews of simulation modelling in UK emergency departments highlight deficiencies in research design (Mohiuddin et al, 2017; Aboueljinane et al, 2013), alongside a continued interest in implementation challenges in healthcare simulation projects (Jahangirian, 2016). With increasing availability of healthcare operational data, opportunities exist to guide real-time decision making (Weiner et al, 2016). This study will explore the challenges and advantages to using real-time data in a hybrid systems modelling approach. Data is supplied by NHSquicker, a digital platform which provides information to low-acuity patients to inform their decision-making regarding urgent treatment (Mustafee et al, 2017). It provides current live wait-times for urgent-care centres in the South West. In order to evaluate the importance of this data, a questionnaire will investigate the influence of NHSquicker on patient decisions. This forms part of a wider evaluation to determine the value of the data prior to utilising it within a hybrid study.

20/03/2018 : 15:30-16:30 : Wordsworth Room 1

Panel Session I (Room 1)

Session Chair: Kathy Kotiadis

Discussing the challenges of stakeholder involvement and how to overcome them

Panellists: Sally Brailsford, Antuela Tako, Stewart Robinson, C Philipps, Mark Elder

Involving stakeholders in simulation studies is not necessarily taught in simulation courses yet has been advocated by several academics and is considered to be common practice in industry. The key benefit of their involvement is that modellers address the right problems, leading to a better understanding of these by all those involved and thus making the implementation of findings more likely.

The audience and panel of experts will be asked to contribute their experience of a stakeholder engagement challenge(s) through anecdotes. The most amusing anecdote will win a prize! The panel session will close with top tips for successful client engagement.

20/03/2018 : 16:30-17:30 : Wordsworth Room 1

An Agile Approach to Building Living Business Models with System Dynamics

Kim Warren, (*Strategy Dynamics Ltd, UK*)

Traditional approaches to building system dynamics models start by qualitative mapping of causal relationships between factors believed to explain performance outcomes. The resulting causal-loop diagram (CLD) is then passed to expert modelers who identify the accumulating stocks in the diagram, construct a software model structure, and seek data to produce a working model. The model is then validated before being used to solve the problem. The science of system dynamics suggests a simpler, faster and more reliable process, which moves directly from the performance of concern to a simple, yet quantified and working model of how changing asset-stocks are driving that performance. From there, interdependencies are traced – extending the working model. The method builds in quality from the start by continually checking that the simulation matches reality. Valuable insights emerge throughout the process – as is the case with the “agile” approach that now dominates software development.

Craftbrew: Towards a Low-Cost Brewery Management System with Cloud-Based Simulation and Delivery Route Optimization

Anastasia Anagnostou, Simon J. E. Taylor, David Bell, Shane Kite and Gary Pattison, (*Brunel University London and Saker Solutions UK*)

Craft Brewers are a major SME sector worldwide. These SMEs could benefit from using simulation to improve their production. However, simulation is often far too expensive for these small enterprises. Cloud-based simulation has been proposed as a way of making simulation accessible. However, simulation on its own is not enough. This paper describes the CraftBrew Whole Brewery Management System that builds on previous work to create a full enterprise management system for small brewers. The paper describes the architecture and discusses how delivery route optimization can be implemented to ensure that production plans can be delivered in the most cost-effective manner.

20/03/2018 : 16:30-17:30 : Wordsworth Room 2

Towards a Unifying Conceptual Representation of Hybrid Simulation and Hybrid Systems Modelling

Navonil Mustafee and John Powell, (*University of Exeter, UK*)

Hybrid Simulation (HS) seeks to capitalise on the synergies of the combined application of conventional modelling approaches like SD, DES and ABS in the model implementation stage of a simulation study. Its objective is to better represent the system under scrutiny. Hybrid Systems Modelling (HSM), on the other hand, is the combined application of simulation with methods and techniques from disciplines such as Applied Computing, Computer Science, Engineering and the wider OR. HSM can be applied to multiple stages of a simulation study, thus being an enabler to Hybrid Modelling & Simulation studies. In this paper, we present a classification of HS and extend it to include HSM approaches which use simulation with other OR techniques. The paper contributes to the debate on what constitutes HS and offers a unifying conceptual representation for mixing simulation approaches with HSM methods and techniques.

A Bootstrap Approach to Multiple Comparison Control

Christine Currie, Thomas Monks and Marion Penn, (*University of Southampton, UK*)

Multiple comparison control (MCC) procedures are used when comparing many different scenarios simultaneously and are designed to ensure that sufficient replications are made to keep the probability of making a single type I error within reasonable bounds. We focus on simulation studies and present an approach based on bootstrapping to assess the variability in the pairwise comparisons between different scenarios. Such methods are particularly useful when a large number of scenarios are being compared because in this case, classical MCC procedures tend to suggest that an impossibly large number of replications are needed to obtain a significant result. In this paper we describe a Python implementation of bootstrapping and apply it to a simple textbook example and a more complex real example from health care.

21/03/2018 : 08:45-10:00 : Wordsworth Room 1

KEYNOTE SPEAKER

Visual Presentation of Simulation Results

Russell C.H. Cheng, (*University of Southampton, UK*)

Discrete event simulation (DES) is an area of operational research that has seen wide application and success. The results of a DES study, typically numerical, can be extensive, making their effective presentation problematic. This talk will look at visual methods of presentation, arguing that this is in accord with the growing area of data-driven studies. If used effectively, such a presentation can become an analytical tool in its own right, enabling conclusions to be drawn without the need for complicated technical statistical analysis.

21/03/2018 : 10:30-11:30 : Wordsworth Room 1

Conceptual Modelling for Simulation: A Ten Year Review

Stewart Robinson, (*Loughborough University, UK*)

In 2007 the Journal of Simulation ran what I believe was the first ever journal issue dedicated to the topic of conceptual modelling for discrete-event simulation. The editorial for that issue reported on a 2006 meeting of conceptual modelling researchers and highlighted a set of research themes in conceptual modelling. Just over ten years since that special issue this paper reviews the progress that has been made in conceptual modelling research through a review of the literature on the topic. There has been significant activity on some research themes, especially conceptual modelling frameworks and representation. There remain, however, many underexplored and unexplored themes. A number of themes, not anticipated in 2006, have also emerged in the last ten years. There is much more work to be done in conceptual modelling research and a need to link more closely with practice.

The Simulation Reproducibility Crisis. Can Reporting Guidelines Help?

Thomas Monks, Christine Currie, Bhakti Stephan Onggo, Martin Kunc, Stewart Robinson and Simon J. E Taylor, (*University of Southampton, Trinity College Dublin, Loughborough University, Brunel University London*)

Modern computational science is gripped by a reproducibility crisis. This means that the benefits of computational research are hard if not impossible to realise. The field of computer simulation is not immune to this crisis. The complexity of simulation models leads to difficulties in reporting the internal logic and data to an extent where it is often difficult to reproduce the model and its results. We describe the reproducibility crisis and introduce the Strengthening the Reporting of Empirical Simulation Studies (STRESS) guidelines; a standardised checklist approach to improve the reporting of discrete-event simulation, system dynamics and agent-based simulation models. We argue that STRESS provides a partial solution to the reproducibility crisis in computer simulation.

21/03/2018 : 10:30-11:30 : Wordsworth Room 2

Can we Learn from Wrong Simulation Models? A Preliminary Experimental Study on User Learning

Naoum Tsiptsias, Antuela Tako and Stewart Robinson, (*Loughborough University, UK*)

A number of authors believe that wrong models can be useful, providing learning opportunities for their users. This paper details an experiment on model complexity, investigating differences in learning after using a simplified versus an adequate version of the same model. Undergraduate students were asked to solve a resource utilization task for an ambulance service. The treatment variables were defined as the model types used (complex, simple, and no model). Two questionnaires (before and after the process) and a presentation captured participants' attitudes towards the solution. Results suggest differences in learning were not significant, while simple model users demonstrated a better understanding of the problem. This paper consists of a preliminary behavioural operational research study that contributes towards identifying the value of wrong simulation models from the perspective of model users.

Simulating Classroom Lessons: An Agent-Based Attempt

Fred Ingram and Roger Brooks, (*Lancaster University, UK*)

This is an interim report on a project to construct an agent-based simulation that reproduces some of the interactions between students and their teacher in classroom lessons. In a pilot study, the activities of 67 students and 7 teachers in 40 lessons were recorded using a data collection instrument that captures 17 different student states and 12 for the teacher. This data enabled various conceptual models to be explored, providing empirical values and distributions for the model parameters. The data can be 'played back' using a data visualization program implemented in NetLogo. A visualization and simulation can be viewed side-by-side and their outputs compared in various ways, e.g. overall class state-transition matrices or individual student state profiles and trajectories. The main challenges are the formulation of descriptive rules and establishing how best to assess the 'accuracy' of the simulation output.

21/03/2018 : 11:30-12:30 : Wordsworth Room 1

Panel Session II (Room 1)

Session Chair: Peer Olaf Siebers

Model Development Strategies: From a Copy/Paste Mentality to Truly Innovative Approaches

Panellists: Peer Olaf Siebers, Antuela Tako, Dave Buxton, Tom Monks and Kim Warren

A recent informal survey at the ABM 17 (ABM17 2017) confirmed once more that the community of agent-based modellers partially suffers from the fact that, despite of its increasing popularity, there is no standard way of addressing model development. This becomes even more of a problem for larger, collaborative, and multi-disciplinary projects. In this panel session we will discuss if this problem also exists in Operational Research for the diverse simulation paradigms we are using (discrete-event, system dynamics, agent-based and hybrid simulation) or if we are well equipped with model development strategies. I would also like to find out what methods (if any) the audience (academics vs practitioners) is using and what the need for further development is in this area.

21/03/2018 : 13:30-15:00 : Wordsworth Room 1

Designing and Redeveloping Generic Models in Healthcare

Marion Penn, Thomas Monks, Anna Kazmierska and Mohamed Alkoheji, (NIHR CLAHRC Wessex, University of Southampton and Southampton Business School, University of Southampton UK)

There is an ongoing concern among those applying operational research in healthcare about the limited evidence of implementation of modelling. This paper explores whether and how the development of generic models can impact on implementation. We discuss the designing of a basic generic simulation model of a hospital ward and its redevelopment into a generic intensive care unit model. We discuss the features of the models that make them generic as well as how the models represent the problems under consideration. The implementation of the models so far is considered along with ongoing work to make them more widely available. Generic modelling and model redevelopment are also discussed more generally

Using Discrete Event Simulation to Improve Operational Performance in Endoscopy Units

Richard Guerrero-Ludueña, (University of Southampton, UK)

With an increase demand for endoscopy services, there is a greater need for improving the efficiency of patient care within gastrointestinal endoscopy units. This project evaluates the operational performance of an endoscopy unit, and proposes ways to increase both the efficiency and the patient experience through a reduction of patient Length of Stay (LoS) at the unit. Patient time records were collected and analysed, and a Discrete Event Simulation (DES) model of a five room gastrointestinal endoscopy unit was built. After validation of the model using a baseline scenario, alternative configurations were tested to run the endoscopy suite; these included altering appointment schedules, physician schedules, as well as changing admission, procedure and recovery configuration. Several 'what-if' scenarios were analysed and a set of potential changes to improve the service efficiency and patient experience, with no extra investment required, were presented to the Hospital trust involved in the project.

Building Capability in Healthcare Modelling Within Aneurin Bevan University Health Board

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Aneurin Bevan University Health Board is unusual in that it has 4 mathematical modellers within its continuous improvement team, who have, to date, undertaken over 70 projects for various health board departments. The projects have varied from data analytics to determining the optimal configuration of a new service. Whilst the team has been very successful and could continue to undertake projects, it has become apparent that other people within the health board could, if provided with the necessary tool kit, carry out similar pieces of work. This paper documents the case studies of three such health board employees that undertook discrete event simulation projects to understand demand and capacity within their services: trauma and orthopaedic and the adult weight management service. Whilst the two services are very different, the case studies illustrate the power of using simulation as an approach for members of the health board.

21/03/2018 : 15:00 : Conference Close and Coffee