ABSTRACTS

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Please find below the abstracts of papers for presentation at the SW18 Simulation Workshop.
Date and time of these presentations will be available soon.

CONCEPTUAL MODELLING FOR SIMULATION: A TEN YEAR REVIEW

Stewart Robinson, (Loughborough University)

Abstract. 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)

Abstract. 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.

VISUAL PRESENTATION OF SIMULATION RESULTS - KEYNOTE

Russell Cheng, (University of Southampton)

Abstract. 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.

USING DISCRETE EVENT SIMULATION TO IMPROVE OPERATIONAL PERFORMANCE IN ENDOSCOPY UNITS

Richard Guerrero-Ludueña, (University of Southampton)

Abstract. 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.

SIMULATING CLASSROOM LESSONS: AN AGENT-BASED ATTEMPT

Fred Ingram and Roger Brooks, (Lancaster University)

Abstract. 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.

AN APPLICATION OF OBJECT-FUNCTIONAL PROGRAMMING TO SIMULATION MODELLING FOR DEFENCE

Gareth Toomey, Paul Glover and Rick Ansell, (Dstl)

Abstract. 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.

IDENTIFICATION OF THE SKILLS REQUIRED FOR DISCRETE EVENT SIMULATION PROJECT ANALYSTS

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

Abstract. 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.

BED.P.A.C: A SIMULATION MODEL FOR THE PLANNING OF HOSPITAL BEDS AND WORKFORCE

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

Abstract. 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.

BUILDING CAPABILITY IN HEALTHCARE MODELLING WITHIN ANEURIN BEVAN UNIVERSITY HEALTH BOARD.

Tracey England, (Cardiff University), Tom Smith, (ABUHB), Paul Harper, (Cardiff University), John Boulton, (ABCi, ABUHB), Emma-Jayne Lewis, (Therapies Service, ABUHB) and Iestyn Davies, (ABUHB),

Abstract. 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.

INPUT MODEL UNCERTAINTY ASSESSMENT: A STUDY WITHIN THE AUTOMOTIVE INDUSTRY

Panagiotis Ioannidis, (Lancaster University), Bhakti S. S. Onggo, (Trinity College Dublin), Michael Higgins and John Ladbrook, (Ford Motor Company)

Abstract. 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.

AIRLINE DISRUPTION RECOVERY USING SYMBIOTIC SIMULATION AND MULTI-FIDELITY MODELLING

Luke Rhodes-Leader, (Lancaster University), Bhakti Stephan Onggo, (Trinity College Dublin), David J. Worthington, (Lancaster University) and Barry L. Nelson, (Northwestern University).

Abstract. 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).

Abstract. 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.

EFFECTIVE PROVISION OF CRITICAL CARE SERVICES: A SIMULATION MODEL

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

Abstract. 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.

DESIGNING AND REDEVELOPING GENERIC MODELS IN HEALTHCARE

Marion Penn, Thomas Monks, Anna Kazmierska and Mohamed Alkoheji, (University of Southampton)

Abstract. 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.

CRAFTBREW: TOWARDS A LOW-COST BREWERY MANAGEMENT SYSTEM WITH CLOUD-BASED SIMULATION AND DELIVERY ROUTE OPTIMIZATION

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

Abstract. 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.

AN AGILE APPROACH TO BUILDING LIVING BUSINESS MODELS WITH SYSTEM DYNAMICS

Kim Warren, (Strategy Dynamics Ltd.)

Abstract. 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.

CAN WE LEARN FROM WRONG SIMULATION MODELS? A PRELIMINARY EXPERIMENTAL STUDY ON USER LEARNING

Naoum Tsioptsias, Antuela Tako and Stewart Robinson. (Loughborough University)

Abstract. 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.

DETERMINISTIC SIMULATION AND GRAPHICAL REPRESENTATION OF POWERED MATERIAL HANDLING VEHICLE MOVEMENTS TO ENHANCE PEDESTRIAN SAFETY

Michael Higgins (Ford Motor Company), Gaurav Khalwadekar (ARRK Europe Ltd. (Based at Ford Dunton Technical Centre)) and John Ladbrook (Ford Motor Company).

Abstract. 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.

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, (University of Nottingham)

Abstract. 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 Simphony 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.

A BOOTSTRAP APPROACH TO MULTIPLE COMPARISON CONTROL

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

Abstract. 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.

TOWARDS A UNIFYING CONCEPTUAL REPRESENTATION OF HYBRID SIMULATION AND HYBRID SYSTEMS MODELLING

Navonil Mustafee and John Powell, (University of Exeter)

Abstract. 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.

RIGHT HOSPITAL- RIGHT TIME: A BUSINESS ANALYTICS FRAMEWORK FOR ANALYSING URGENT CARE/A&E WAIT TIME DATA

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

Abstract. 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.