



THE SOCIETY FOR
MODELING & SIMULATION
INTERNATIONAL

SPRINGSIM

Spring Simulation Multi-Conference 2015

APRIL 12-15, 2015

The Westin Alexandria; Alexandria, VA (DC Area) USA



2015 SpringSim

PROGRAM BOOK

April 12–15, 2015
Alexandria, VA, USA

General Chair
Saikou Diallo

Vice-General Chair
Navonil Mustafee

Program Chair
Saurabh Mittal

SCS/SpringSim'15 Thanks the following Sponsors:



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GENERAL INFO

General Information

Registration

Your registration for SCS's 2015 Spring Simulation Multi-conference (SpringSim'15) includes morning and afternoon breaks each day, the Monday evening reception in the Edison D room and access to all sessions, tutorials and special presentations (unless otherwise noted).

- **Registration Hours** (*Edison Foyer*):
 - ◇ **Sunday**, April 12th – 1600-1800
 - ◇ **Monday**, April 13th – 0700-1700
 - ◇ **Tuesday**, April 14th – 0700-1700
 - ◇ **Wednesday**, April 15th – 0730-1500

Please note that the Registration Desk will be closed for lunch Mon-Wed from 1200-1330

Breaks

- **Coffee Breaks** (*Edison D*):
 - ◇ **Monday**, April 13th – 1000-1030 | 1500-1530
 - ◇ **Tuesday**, April 14th – 1000-1030 | 1500-1530
 - ◇ **Wednesday**, April 15th – 1000-1030 | 1500-1530

Plenary/Keynotes

- **Plenary Session and Keynotes** (*Edison ABC*)
 - ◇ **Monday, Tuesday, Wednesday** 0830-1000 (See Keynote pages for more information on the speakers)

General Information

Conference Meetings & Happenings

- • **Sunday:**
 - SCS Board Meeting (0800-1200); Hopkins Room
*SCS Board Members
 - Tutorials (1030-1800); Edison BC
Student Colloquium/Poster Presentations/M&S Mobile App (1000-1630); Edison EF
*All conference attendees invited (See agenda for details)
 - Social Event for Student Colloquium (1830) Delia's
Mediterranean Grill & Brick Oven Pizza, 209 Swamp Fox Rd.
- • **Monday:**
 - Plenary Session (0830-1000); Edison ABC
Welcome (0800-900)
Keynote Address Dr. Wesley J. Wildman (0900-1000)
 - Conference Organizers Planning Lunch (1200); Bell Room
*By Invitation Only
 - Welcome Reception (1730-1900); Edison D
*All conference attendees invited
- • **Tuesday:**
 - Plenary Session (0830-1000); Edison ABC
Announcements (0830-0900)
Keynote Address Prof. Sally Brailsford (0900-1000)
 - Spring 2016 Organization Planning Meeting with Symposia Chairs (1200); Bell Room *By Invitation Only
 - SCS Membership Meeting (1715-1800); Edison B
*SCS members and future members invited; Snacks & Drinks will be served
 - DC Night Tour (meet in lobby at 1915, bus leaves at 1930 sharp!)
*Pre-purchased ticket holders only, see Reg Desk for questions
- • **Wednesday:**
 - Plenary Session (0830-1000); Edison ABC
Best Paper Award (0830-0900)
Keynote Address Jesse J. Citizen, Jr. (0900-1000)

General Information

Monday Evening Welcome Reception

There will be a Welcome Reception in Edison D open to all SpringSim'15 attendees, on Monday, April 13th, from 1730-1900.

Speakers' Breakfasts

Speakers' breakfasts will be held Monday – Wednesday from 0700 – 0815, located in the Bell room. The presenters for each day are invited to join their session chairs at a breakfast on the morning of their presentation. Each paper's presenter should receive a ticket with their registration material indicating the time, day and room for the breakfast they may attend.

Best Paper Award

The Award for the Best Paper of SpringSim'15 will be presented at Wednesday's Plenary Session.

Student Colloquium/M&S Mobile App Competition/Posters

The Student Colloquium, M&S Mobile App, and Poster presentations will take place on Sunday, April 12 (see agenda for more details).

Student Colloquium: The colloquium is intended to bring together students in both early and advanced stages of their careers who are working on any modeling and simulation topics, to provide them a friendly forum and an opportunity to present, discuss and illustrate their ongoing research in a constructive and enjoyable atmosphere.

M&S Mobile App Competition: The purpose of the app competition is to engage students in application development related to M&S, incorporating various related topics that can be integrated in a mobile app. The application can be as simple as a remote M&S interface on a tablet device, to as complicated as M&S tool running on such a device. This competition is intended to promote M&S applications on smart phones and tablet devices.

Posters: These outstanding short paper submissions will be presented in a poster format at the conference. The short papers present interesting recent results, novel ideas or works-in-progress that are not quite ready for a full-length paper.

Upcoming SCS Events

2015 Summer Simulation Multi-Conference

July 26-29, 2015

Palmer House Hilton; Chicago, IL, USA

The Summer Simulation Conference 2015 (SummerSim'15) is SCS's premier international conference in cooperation with ACM SIGSIM. The conference focuses on modeling and simulation, tools, theory, methodologies and applications and provides a forum for the latest R&D results in academia and industry. This year's focus is on hybrid, discrete and continuous systems, and advanced modern applications thereof. We encourage you to take this opportunity to experience the tutorials, tracks, and workshops that will be available. SummerSim'15 includes the following events: 47th Summer Computer Simulation Conference (SCSC 2015), and the International Symposium on Performance Evaluation of Computer and Telecommunication Systems (SPECTS 2015).

2016 Power Plant Simulation Conference

February 1-3, 2016

Holiday Inn Riverwalk; San Antonio, TX, USA

The 2016 Power Plant Simulation Conference (PowerPlantSim'16) is an annual conference sponsored by SCS. This conference focuses on the special needs of the nuclear and fossil power plant simulation community and includes presentations by technology and industry leaders, technical sessions, panel and roundtable discussions, and vendor exhibits. The primary goal of the conference is to promote open exchange of simulator related information between all attendees. All individuals associated with the maintenance, management, regulation, or application of nuclear and fossil power plant simulators are encouraged to participate by submitting original presentations.

2016 Spring Simulation Multi-Conference

April 3-6, 2016

The Westin Pasadena; Pasadena, CA, USA

The Spring Simulation Multi-Conference 2016 (SpringSim'16) brings leading experts in various domains of Modeling and Simulation together. The Theory of Modeling and Simulation (TMS/DEVS 2016) will be a sub-conference of SpringSim. The following symposia are typically organized under SpringSim: Annual Simulation Symposium (ANSS), Agent-Directed Simulation (ADS), Communications and Networking Symposium (CNS), High Performance Computing Symposium (HPC), Symposium on Simulation for Architecture and Urban Design (SimAUD), Modeling and Simulation in Medicine (MSM), Poster Session and Student Colloquium.

Please visit www.scs.org/conferences for more information on our conferences.

Welcome to SpringSim'15

Welcome from the General Chair

Dear Colleagues and friends,

On behalf of the Organizing Committee, I am delighted and honored to welcome you to the Spring Simulation Multi-Conference 2015 (SpringSim'15) in Alexandria, Virginia.

The Society for Modeling & Simulation International (SCS) which organizes Springsim is one of the oldest Modeling and Simulation organizations in the world. It endeavors to promote the advancement of Modeling and Simulation and connect Modeling and Simulation professionals worldwide. The SpringSim'15 program includes a world-class selection of peer-reviewed paper, presentations, distinguished keynote speeches and tutorials. In addition, SpringSim'15 offers 1) a poster track for students to showcase their work and receive feedback 2) a Ph.D. colloquium where students and established professionals can meet and exchange ideas and 3) for the first time a student **mobile application competition** where they can show how Modeling and Simulation can be meshed with new technologies. Great thanks to the organizations that have donated money, licenses and books to recognize the best submissions at this conference.

I would also like to thank our keynote speakers **Prof. Wesley Wildman**, **Prof. Sally Brailsford** and **Mr. Jesse Citizen** for graciously accepting to share their vast knowledge and experiences with us. My thanks also go to all members of the Organization Committee for their tireless efforts especially in working through the introduction of a new format and editing process. It was truly a team effort. The committee consists of:

Vice-General Chair	Navonil Mustafee, Exeter University
Program Chair	Saurabh Mittal, Dunip Technologies, LLC
Proceedings Chair	Shafagh Jafer, Embry-Riddle Aeronautical University
Awards Chair	Umut Durak, DLR
Tutorial Chair	Jose Padilla, VMASC
Publicity Chair	Gregory Zacharewicz, Université Bordeaux I
Sponsorship Chair	Andreas Tolk, Simis, Inc.

As a Multi-Conference, our success depends heavily on the track organizers, reviewers and committee members. I am very grateful for the efforts of all of the volunteers that dedicated their time and effort to review and edit all of the submissions and thus make this gathering possible. I also express my gratitude to authors and tutorial presenters for their important contributions.

My sincere appreciation goes to the symposia chairs, whose invaluable efforts in their respective sections were key to the success of the overall multi-Conference. This year's symposia chairs are:

Welcome to SpringSim'15

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- Agent-Directed Simulation (ADS) Symposium, chaired by Levent Yilmaz and Tuncer Ören,
- Communications and Networking Symposium (CNS), chaired by Abolreza Abhari and Hala ElAarag
- High Performance Computing Symposium (HPC), chaired by Layne Watson and Josef Weinbub
- Symposium on Simulation for Architecture and Urban Design (SimAUD), chaired by Shajay Bhooshan and Holly Samuelson
- Theory of Modeling and Simulation (TMS/DEVS), chaired by Fernando Barros and Moon Ho Hwang
- Annual Simulation Symposium (ANSS), chaired by Andreas Tolk and Shafagh Jafer
- Modeling and Simulation in Medicine (MSM) chaired by Jerzy Rozenblit and Johannes Sametinger
- Tutorial and Vendor Track, chaired by Jose Padilla
- Posters session & Student Colloquium, chaired by Salim Chemlal and Mohamed Moallemi
- Work in Progress session chaired by Gregory Zacharewicz

Special thanks go to the SCS officers, **Oletha Darensburg**, **Aleah Hockridge** and the team for their high level of professionalism, and for the smooth running of all the events.

Alexandria is one of the oldest cities in the United States and has an historic *Old Town* with great dining and shopping. In addition, please feel free to sign up for our organized night tour to see the various monuments and cultural centers in Washington, D.C.

Welcome to Springsim'15



Saikou Diallo, Ph.D.

General Chair SpringSim 2015

Old Dominion University, Virginia, Modeling Analysis and Simulation Center

Simulation Exploration Experience

Simulation Exploration Experience (SEE)

Wright Room

The Simulation Exploration Experience (SEE) joins students, industry, professional associations, and faculty together for an annual modeling and simulation (M&S) challenge. SEE, led by NASA, champions collaborative collegiate-level modeling and simulation by providing a venue for students to work in highly dispersed inter-university teams to design, develop, test, and execute a simulated lunar mission. Participating teams gain valuable knowledge, skills, and increased employability by working closely with industry professionals, NASA, and faculty advisors.

WHAT IS SEE?

- SEE is a distributed simulation challenge. Geographically distributed inter-university teams work in conjunction with one another to design, develop, test, and execute a simulated lunar mission.
- SEE is a way to engage students in Modeling and Simulation education.
- Proof that interoperability and standards matter. Participating teams make use of SISO standards, which allow the distributed parts of the simulation to work seamlessly.
- A simulation of real-world M&S work. Participating teams experience real M&S work during SEE, providing them with valuable skills, experience, and increased employability.

Schedule of SEE Events:

Sunday, 12 April

1745–1830 SEE Event Posters (in conjunction with the Poster & Student Colloquium Sessions) Theme: “Challenges and opportunities in developing distributed simulation of complex systems and real time applications among highly dispersed teams”

Room: Edison EF Chair: Stephen Paglialonga

Monday, 13 April

1530–1700 Faculty Panel Discussion
“Creating Challenging and Creative college-level distributed modeling & simulation education” Panelists: Agostino Bruzzone, Simon Taylor, Karl Siebold, Neil Cameron, Francesco Longo, Alfredo Garro, Greg Zacharewicz

Room: Wright Chair: Agostino Bruzzone

Tuesday, 14 April

1200–1330 SEE Lunar Operations Live-Lunar Operations, Aikens Basin, on the farside of the Moon. A live, distributed simulation event and study University Teams: Alberta, Bordeaux, Brunel, Calabria, Genoa, Liverpool, Munich, Nebraska

Room: Wright Chair: Michael Conroy

1530–1600 SEE Awards Ceremony
Honoring student team academic, technical and teamwork achievement, support of American Indian Higher Education Consortium

Room: Wright Chair: Stephen Paglialonga

TUTORIALS

Tutorials Information

Tutorial Schedule (April 12th, Sunday)

Tutorial Chair: Jose Padilla

Room: Edison BC

Modeling More than Two Decision Makers: Agent-Based Modeling and Game Theory

Time: 1030–1200

Speaker: Andrew J. Collins

Affiliation: Virginia Modeling, Analysis and Simulation Center,
Old Dominion University

LUNCH BREAK 1200-1300

Conceptual Model Verification with Alloy

Time: 1300–1430

Speaker: Ross J. Gore

Affiliation: Virginia Modeling, Analysis and Simulation Center,
Old Dominion University

BREAK 1430-1445

From Concept to Multi-Paradigm Simulation

Time: 1445–1615

Speaker: Christopher J. Lynch

Affiliation: Virginia Modeling, Analysis and Simulation Center,
Old Dominion University

BREAK 1615-1630

Model-based Simulation Engineering

Time: 1630-1800

Speaker: Umut Durak

Affiliation: German Aerospace Agency (DLR), Institute of Flight
Systems

Tutorials Information (Cont.)

Modeling More than Two Decision Makers: Agent-Based Modeling and Game Theory

Time Slot: 1030-1200

Speaker: Andrew J. Collins

Affiliation: Virginia Modeling, Analysis and Simulation Center, Old Dominion University

Abstract

There is more than one way to skin a cat and there is more than one way to model situations involving groups of people. In this workshop we look at two such paradigms: agent-based modeling (ABM) and n-person game theory. Background and theoretical foundations will be discussed of both paradigms. For agent-based modeling, discussion will be given on complex adaptive systems, emergent behavior, and heterogeneity. Examples shown will include Schelling's segregation model, predator-prey and Reynold's Boids. For n-person game theory, some background in general game theory is given first before a discussion on the characteristic function, core, nucleolus, and Shapley value. The examples games include three guns, tolling auction game, and the Lilliput Security Council. By the end of the workshop, the participants will have a basic understanding of both paradigms and will be able to recognize key terminology connected to them. This workshop is not for the mathematically shy so beware: equations will be used. There might be a fun game or two played as well.

Tutorials Information (Cont.)

Conceptual Model Verification with Alloy

Time Slot: 1300-1430

Speaker: Ross J. Gore

Affiliation: Virginia Modeling, Analysis and Simulation Center, Old Dominion University

Abstract

The process of developing, verifying and validating models and simulations should be straightforward. A conceptual model is designed by a subject matter expert (SME) from careful consideration of a problem and its domain. Then, it is realized via a source code simulation through the implementation of interfaces, data structures and algorithms. Finally, the output of the simulation for a set of test cases is validated against historical data or other trusted sources. Unfortunately, naively following this approach has pitfalls. The design of a conceptual model that appeared complete and robust can become incoherent, incomplete and potentially invalid during simulation implementation. As a result, exploring alternative models and alternative modeling questions becomes impossible because SMEs are unable to identify the respective modifications that need to be made to the simulation.

An alternative approach is to attack the needed exactness head-on by employing model checking to verify conceptual models. Verification via model checking has had a number of major successes but is rarely used in practice. Model checkers can require a level of investment which can exceed what one might expect from most SMEs. In this tutorial we focus on a more light weight approach to verification with Alloy. Using Alloy, conceptual models are developed incrementally, driven by the modeler's perception of which aspects of the system matter most in a more familiar syntax. At completion of the tutorial attendees will be introduced to a tool that allows them to discover where the greatest risks in their models lie and a means to identify them as early as possible.

Tutorials Information (Cont.)

From Concept to Multi-Paradigm Simulation

Time Slot: 1445-1615

Speaker: Christopher J. Lynch

Affiliation: Virginia Modeling, Analysis and Simulation Center, Old Dominion University

Abstract

This session will provide an introductory, hands-on tutorial for developing and implementing models using multiple modeling paradigms. The construction of the model will be presented through the development of reference, conceptual, and simulation models with respect to a use case. The conceptual model will be constructed using the Unified Modeling Language (UML) and the simulation tool AnyLogic will be used to construct the simulation. The modeling paradigms include discrete event simulation (DES), system dynamics (SD), and agent-based modeling (ABM). The modeling question deals with representing the weight change among individuals based on their surroundings. This will be accomplished by capturing the connections between individuals using ABM, a utility function for determining where to eat using SD, and the representation of restaurants using DES.

Free trials for the tools used for the tutorial are available from the following links (note that only one UML tool is needed):

- Enterprise Architect (for UML): <http://www.sparxsystems.com/products/ea/trial.html>
- Astah (for UML): <http://astah.net/download#professional>
- AnyLogic (for the simulation): <http://www.anylogic.com/downloads>

Tutorials Information (Cont.)

Model-based Simulation Engineering**Time Slot: 1630-1800****Speaker: Umut Durak****Affiliation: German Aerospace Agency (DLR), Institute of Flight Systems****Abstract**

The famous adage “A picture is worth a thousand words” can be pronounced as the biggest motivation of employing models in engineering domain. Engineers have long been trying to tackle the complexity of their products by employing pictures (models) to communicate their abstractions. Recent model-driven and model-based approaches are attempting to stress the employment of models in engineering in a more structured way. While model-driven development (MDD) proposes a development paradigm that utilizes models as the primary artifacts and redefines the implementation as (semi)automatic generation from the models. Model-driven engineering on the other hand expands the MDD to cover all engineering process areas. On the other hand model-based engineering (MBE) is defined as utilizing model-driven practices pragmatically, not necessarily in an integrated fashion, in various steps of the engineering process. Simulation engineering can be defined as the art of developing, employing and maintaining simulations using the fundamental theories of simulation science. IEEE 1730, The Recommended Practice for Distributed Simulation Engineering and Execution Process provides us with a shared understanding on simulation engineering process for particularly distributed simulations, but it can also be adopted for all simulations. In this tutorial, after presenting basic model-driven practices including modeling languages, metamodeling, model transformations and code generation, sample cases that employs these practices in particular steps of simulation engineering process will be presented. These steps will include conceptual analysis, design and development of simulation environment, integration and test, and modernization. Thus, the attendees will be introduced with examples of MBE.

KEYNOTES

Keynotes Information

TITLE: Simulation in the Scientific Study of Religion

AUTHOR: Wesley J. Wildman, PhD

LOCATION: Edison ABC

TIME: 0900-1000

DAY: Monday, April 13, 2015



ABSTRACT:

Simulation and modeling techniques have been applied with increasing success to human social processes. They have also been applied to human behaviors involving complex cognition. During the last few years, moreover, social scientists and cognitive scientists have also been building sophisticated theories pertaining to the origins and functions of religious beliefs, behaviors, and experiences, often supported by experimental or demographic studies. The combination of these developments has made it possible to apply simulation and modeling techniques within the scientific study of religion in a useful way for the first time. It is early days but the effects have been, and promise to be, three. First, otherwise highly speculative and often abstract theories about religion can be expressed more precisely. Second, theories about religion can be tested against complex datasets. Third, competing theories about religion can be compared meaningfully. All three effects can foster consensus and revolutionary advance in the scientific study of religion.

SHORT BIO:

Wesley J. Wildman, PhD, is Convener of Boston University's PhD program in Religion and Science. He co-founded the Institute for the Bio-cultural Study of Religion, a non-profit research institute dedicated to the scientific study of religion. He co-founded and continues to edit one of the leading peer-reviewed journals in the field, *Religion, Brain & Behavior*. Author of many books and articles in the academic study of religion, he is currently leading the Institute's effort to increase the visibility of simulation and modeling techniques in the scientific study of religion.

Keynotes Information

TITLE: Overcoming the Barriers: Getting Simulation Used in Healthcare

AUTHOR: Professor Sally Brailsford

LOCATION: Edison ABC

TIME: 0900-1000

DAY: Tuesday, April 14, 2015



ABSTRACT:

Despite a vast academic literature, Operations Research modeling in general, and simulation in particular, has failed to become embedded and widely implemented as a practical management tool within most healthcare organizations. The reasons for this remain unclear, but the overwhelming majority of published papers are either purely theoretical or report individual one-off success stories. In this talk I shall present some personal success stories from 25 years of working in this field, and shall explore the factors influencing the successful adoption of simulation models within healthcare organizations.

SHORT BIO:

Sally is Professor of Management Science at the University of Southampton. She obtained a BSc in Mathematics from Kings College London, and then worked as a nurse in the UK National Health Service before obtaining an MSc and then a PhD in Operational Research from Southampton. Her research is in the area of healthcare simulation modelling: to evaluate treatments and screening programmes, or to redesign and improve service delivery. Sally has worked for over 25 years in many different disease fields including diabetes, cancer, mental health and HIV/AIDS, in addition to emergency care and end-of-life care. She is a Vice-President of EURO, the Association of European OR Societies, and chair of the EURO Working Group on OR Applied to Health Services (ORAHS). She is one of the Editors-in-Chief of the UK OR Society's new journal Health Systems and is on the editorial boards of Health Care Management Science, the Journal of Simulation and Operations Research for Health Care. She has twice won the UK OR Society's Goodeve Medal, in 2004 for modelling emergency healthcare services in Nottingham, and in 2006 for modelling chlamydia infection.

Keynotes Information

TITLE: AT&L Defense M&S Coordination Office
AUTHOR: Jesse J. Citizen, Jr.
LOCATION: Edison ABC
TIME: 0900-10:00
DAY: Wednesday, April 15, 2015



ABSTRACT:

In this overview of the strategy and emerging configuration for the Defense Modeling and Simulation Coordination Office (DMSCO), I provide a description of the several success stories of DMSCO funded projects, spanning from Cyber to Big Data, including M&S projects completed in FY 2014, and those transitioned to other organizations for program management; and our sustainment of the Defense M&S Catalog, an enterprise level tool. This talk includes a description of the ongoing operations of our DoD M&S Community of Interest (COI), that includes working groups for cyber, data, environmental representation and architectures. In addition, the COI provides a fluid organization for both the development and dissemination of DoD M&S best practices and emerging technologies as we increase our technical focus.

SHORT BIO:

Mr. Jesse Citizen assumed the position of Defense Modeling and Simulation Coordination Office (DMSCO) Director in August 2007. As the director, his organization is charged with enabling DoD to more effectively meet its operational and support objectives using a modeling and simulation capability. Mr. Citizen leverages his broad understanding of DoD missions, portfolio management, professional military operations and experience to encourage M&S collaboration across the diverse Services and federal agencies. Prior to assuming his role as the DMSCO Director, Mr. Citizen served in the Air Force for over 33 years. He culminated his military career at the rank of Colonel, serving as Chief, Modeling and Simulation Policy Division, U.S. Air Force Headquarters, Washington DC. In that position, he was responsible for developing all USAF modeling and simulation policy, as well as providing oversight for all Air Force centrally-managed M&S programs.

Notes

NOTES

MAPS

Hotel Meeting Space Map



SpringSim'15 At A Glance Sessions

		ADS	ANSS	CNS	TMS/DEVS A
Monday	13-Apr-15				
0830 – 1000	SCS Plenary				
1000 – 1030	Break				
1030 – 1200	Session Block I				
1200 – 1330	Lunch (on your own)				
1330 – 1500	Session Block II				
1500 – 1530	Break				
1530 – 1700	Session Block III				
Tuesday	14-Apr-15				
0830 – 1000	SCS Plenary				
1000 – 1030	Break				
1030 – 1200	Session Block IV				
1200 – 1330	Lunch (on your own)				
1330 – 1500	Session Block V				
1500 – 1530	Break				
1530 – 1700	Session Block VI				
Wednesday	15-Apr-15				
0830 – 1000	SCS Plenary				
1000 – 1030	Break				
1030 – 1200	Session Block VII				
1200 – 1330	Lunch (on your own)				
1330 – 1500	Session Block VIII				
1500 – 1530	Break				
1530 – 1700	Session Block IX				

*Posters will be on display during breaks Monday 0800am – 1700pm, Tuesday 0800am – 1700pm,

SpringSim'15 At A Glance Sessions

[illegible]

and Wednesday, 0800am – 1500pm

Notes

AGENDAS

Agent-Directed Simulation (ADS)

Agenda

Monday, 13 April 2015

Session II 1330 – 1500 Room: Edison A Session Chair: Ozgur Ozmen

- *Impacts of Market Behavior on Distributed Energy: A Multi-Disciplinary, Hybridized Modeling and Simulation Approach* (Solomon Sherfey, Andrew Collins, Paul Moses and Sylvain Marsillac)
- *Agent-based Pedestrian Evacuation Modeling: A One-size Fits All Approach?* (Andrew Collins, Erika Frydenlund, Terra Elize and Michael Robinson)
- *Agent-based Simulation for Assessing Network Security Risk due to Unauthorized Hardware* (Neal Wagner, Richard Lippmann, Michael Winterrose, James Riordan, Tamara Yu and William Streilein)

Session III 1530 – 1700 Room: Edison A Session Chair: Jonathan Hood

- *An Agent-based Approach to Modeling Insider Threat* (John Sokolowski and Catherine Banks)
- *Examining Norm Establishment and Spread in Different Organizational Structures Using an Extended Axelrod Model* (Meghendra Singh and Vivek Balaraman)
- *An Agent Based Model to Simulate Farmer Decision Process* (Kasi Bharath Vegesana)

Tuesday, 14 April 2015

Session IV 1030 – 1200 Room: Edison A Session Chair: Navonil Mustafee

- *Synchronising Agent Populations When Combining Agent-Based Simulations* (Bhagya Niroshan Wickramasinghe, Dharendra Singh and Lin Padgham)
- *A Graph-based Agent-oriented Model for Building Occupancy Simulation* (Sanish Rai, Minghao Wang and Xiaolin Hu)

Session V 1330 – 1500 Room: Edison A Session Chair: Yu Zhang

- *Reward-Selective Propagation Cascade Model* (Yu Zhang and Tyler Olson)
- *Defining Behavior of Computational Agents Based on Military Doctrine* (Alexandre de Menezes Villarmosa, Gustavo Henrique Soares de Oliveira Lyrio and Roberto de Beauclair Seixas)

Notes

47th Annual Simulation Symposium (ANSS)

Agenda

Monday, 13 April 2015

Session I 1030–1200 Room: Edison G Session Chair: Jose Padilla

- *Asynchronous Optimization Techniques for Distributed Computing Applications* (Raphael-Elias Reisch, Jens Weber, Christoph Laroque and Christian Schröder)
- *An Investigation of 'Soft' Operations Research Methods to Inform Hybrid Simulation Studies on Environmental Disasters* (Anna Wienke and Navonil Mustafee)
- *An Adaptive Fault-tolerance Scheme for Distributed Load Balancing Systems* (Dan Liu, Robson Eduardo De Grande and Azzedine Boukerche)

Session II 1330 – 1500 Room: Edison G Session Chair: Bharat Madan

- *MOE Quantification of Missions Using Sensor Data Driven Graph Similarity Measures* (Bharat Madan and Doina Bein)
- *Integrating Simulation-Driven Decisions and Business Wargames to Shape Fiscal Policies* (Alejandro Hernandez)
- *A Domain Ontology for Ballistic Missile Defense Conceptual Model* (Wenguang Wang, Feng Yang, Weibing Ma, Xiaobo Li and Yangbo Wu)

Session III 1530 – 1700 Room: Edison G Session Chair: Margery Doyle

- *Knowledge Reformulation and Abstraction for Rapid Model and Agent Development* (Invited Paper) (Margery Doyle, Eric Watz and Antoinette Portrey)
- *Assessing Personality Traits of Simulation-Based Training Scenario Developers* (Stephanie Lackey, Crystal Maraj and Julie Salcedo)
- *An Exploration of Fault Tree Analysis Methods for Military Simulations* (Jeff Hanes)

Tuesday, 14 April 2015

Session IV 1030 – 1200 Room: Edison G Session Chair: Margery Doyle

- *A Tool for Model Conversion Between Simulators of Grid Computing* (Gabriel Covello Furlanetto, Rafael de Souza Stabile, Renata Spolon Lobato, Aleardo Manacero, Roberta Spolon and Denison Menezes)
- *Calculating Grid Partitioning Costs of Distributed Virtual World Simulation Systems* (William Rivera and Amit Goel)
- *Investigating Execution Strategies for Hybrid Models Developed Using Multiple M&S Methodologies* (Navonil Mustafee, M'Hammed Sahnoun, Andi Smart, Phil Godsiff, David Baudry and Anne Louis)

Session V 1330– 1500 Room: Edison G Session Chair: Jose Padilla

- *Paradigms for Conceptual Modeling* (Invited Paper) (Ricardo Roca, Dale Pace, Stewart Robinson, Andreas Tolk and Levent Yilmaz)

47th Annual Simulation Symposium (ANSS)

Agenda

- *Adaptively Perturbing Localized State Space in Data Assimilation of Wildfire Spread Simulation* (Feng Gu)
- *Model-Based Configuration of Automotive Co-Simulation Scenarios* (Martin Krammer, Johannes Fritz and Michael Karne)

Session VI 1530 – 1700 Room: Edison G Session Chair: Andrew Collins

- *Simulation Visualization Issues for Users and Customers* (Andrew Collins, D'An Knowles Ball and Julia Romberger)
- *Effective Visualization in Modeling & Simulation* (Daniele Vernon-Bido, Andrew Collins and John Sokolowski)
- *Agent-based System for Simulating the Dynamics of Social Identity Beliefs* (M. Afzal Upal and Sarah Gibbon)

Wednesday, 15 April 2015

Session VII 1030 – 1200 Room: Edison G Session Chair: Mariusz Balaban

- *The Application of Constructive Modeling and Simulation to Teach Port Management* (Mariusz Balaban, Sara Russell, Thomas Mastaglio and Paulette Dykes)
- *Generating Domain-Specific Simulation Environments from Model Frameworks Based on SMP2 for Rapid Development of Simulation Applications* (Ning Zhu, Jian Yao, Yonglin Lei, Weiping Wang and Yifan Zhu)
- *Universal Simulation Engine (USE) - A Model-Independent Library for Discrete Event Simulation* (Desheng Fu, Matthias Becker and Helena Szczerbicka)

Session VIII 1330 – 1500 Room: Edison G Session Chair: Andreas Tolk

- *Accelerated Portfolio Optimization with Conditional Value-at-Risk Constraints Using a Cutting-Plane Method* (Georg Hofmann)
- *A Comparison of a Generic MCMC-based Algorithm for Bayesian Estimation in C++, R and Julia. Application to Plant Growth Modeling* (Gautier Viaud, Yuting Chen, Benoit Bayol and Paul-Henry Cournede)
- *Bayesian Changepoint Detection for Generic Adaptive Simulation Algorithms* (Tobias Helms, Oliver Reinhardt and Adelinde M. Uhrmacher)

Session IX 1530 – 1700 Room: Edison G Session Chair: Mariusz Balaban

- *The Multi-Craft Problem: A Distributed Simulation Approach Using Networked Floating Objects* (Abir Zubayer, Dennis Peters and Brian Veitch)
- *Estimating the Probability of a Timely Traffic-HazardWarning via Simulation* (Nils Müllner, Sibylle Fröschle and Martin Fränzle)
- *Particle Filter Based Traffic Data Assimilation with Sensor Informed Proposal Distribution* (Peisheng Haidong Xue and Xiaolin Hu)

18th Communications and Networking Symposium (CNS)

Agenda

Monday, 13 April 2015

Session I 1030 – 1200 Room: Edison B Session Chair: Abdolreza Abhari

TOPIC: Big Data and Cloud Computing

- *Automatic Classification of the Emotional Content of URL Documents Using NLP Algorithms (Alaa Hussainalsaid, Bahram Zahir and Abdolreza Abhari)*
- *SALIENT: Stochastic, Adaptive Latency Improvement for Event Notification Trees (Jason Long and Jeremy Blum)*
- *A Fine-Grained Flow Control Model for Cloud-Assisted Data Broadcasting (Ning Yu, Feng Gu, Xuan Guo and Zaobo He)*

Session II 1330 – 1500 Room: Edison B Session Chair: Abdolreza Abhari

TOPIC: Wireless Sensor Networks

- *Comparison of Data Analysis Tools for Trending Thermal Comfort Parameters (Abdolreza Abhari and Lubaid Ahmed)*
- *Contiki Cooja Simulation for Time Bounded Localization in Wireless Sensor Network (Mona Nasser, Hussein Al-Olimat, Robert Green, Mansoo Alam and Wei Cheng)*
- *Follow the Pheromone Trail – On Studying Ant Routing Algorithms in Simulation and Wireless Testbeds (Michael Frey and Mesut Gunes)*

Session III 1530 – 1700 Room: Edison B Session Chair: Abdolreza Abhari and Hala ElAarag

TOPIC: Modeling and Simulation

- *DEVS Based Modeling of Shared Segmented Upload in LTE-A Mobile Networks (Misagh Tavanpour, Jan Mikhail, Gabriel Wainer, Mohammad Moallemi, G. Boudreau, R. Casselman)*
- *Automatic Validation for Multi Criteria Decision Making Models in Simulation Environments (Mubarak Alrashoud, Meshary AlMeshary and Abdolreza Abhari)*
- *Dynamic Link Budget Simulation for High Altitude Balloon Data Link Experiment (James Taylor, Thaine Rowley, KayLee Taylor, Dakota Kilzer, Cody Largent and Makenzie Petersen)*

18th Communications and Networking Symposium (CNS)

Agenda

Tuesday, 14 April 2015

Session IV 1030 – 1200

Room: Edison B

Session Chair: Hala ElAarag

TOPIC: Network Security

- *Malware Detection Inspired By The Human Immune System and Making Use of Honeypot (John Cossu and Hala ElAarag)*
- *Communication Security in the Internet of Things: Preventive Measure for Avoiding DDoS Attacks Over IoT Network (Congyingzi Zhang and Robert Green)*
- *Agent-Based Simulation in Support of Moving Target Cyber Defense Technology Development and Evaluation (Benjamin Priest, Era Vuksani, Neal Wagner, Brady Tello, Kevin Carter and William Streilein)*

Symposium on Theory of Modeling & Simulation (TMS/DEVS)

Agenda

Monday, 13 April 2015

Session TMS_0 1025– 1030 Room: Edison E Welcome

Parallel Sessions TMS_A

Session TMS_1A 1030 – 1200 Room: Edison E Session Chair: Herbert Praehofer

- *Towards a Probabilistic Interpretation of Validity for Simulation Models (James Nutaro and Bernard Zeigler)*
- *A Model-based Trace Testing Approach for Validation of Formal Co-simulation Models (Adisak Intana, Michael Poppleton and Geoff Merrett)*
- *A Method for Quantified Confidence of DEVS Validation (Megan Olsen and Mohammad Raunak)*

Session TMS_2A 1330 – 1500 Room: Edison E Session Chair: James Nutaro

- *Semantic Selection for Model Composition using SAMSaaS (Sixuan Wang and Gabriel Wainer)*
- *SES Extension to Integrate Abstraction Hierarchy into DEVS Modeling and Simulation (Jean-Francois Santucci, Laurent Capocchi and Bernard P. Zeigler)*
- *Visual and Persistence Behavior Modeling for DEVS (Mostafa D. Fard and Hessam S. Sarjoughian)*

Session TMS_3A 1530 – 1630 Room: Edison E Session Chair: Norbert Giambiasi

- *Superdense Time Trajectories for DEVS Simulation Models (Hessam Sarjoughian and Savitha Sundaramoorthi)*
- *Integrating Web-based Simulation on IT Systems with Finite Probabilistic DEVS (Chungman Seo, Bernard Zeigler, Doohwan Kim and Kenneth Duncan)*

Session TMS_PhD 1630 – 1700 Room: Edison E Session Chair: Claudia Frydman

- *PhD Session*

Parallel Sessions TMS_B

Session TMS_1B 1030 – 1200 Room: Edison F Session Chair: Andrea D'Ambrogio

- *SpSIR: A Spatially-Dependent Sequential Importance Resampling For High Dimensional Spatial Temporal System Simulation (Yuan Long and Xiaolin Hu)*
- *Explicit Semantic Adaptation of Hybrid Formalisms for FMI Co-Simulation (Joachim Denil, Bart Meyers, Bart Pussig, Paul De Meulenaere and Hans Vangheluwe)*
- *Asynchronous ODE Solvers based on Error Estimation (Fernando Barros)*

Symposium on Theory of Modeling & Simulation (TMS/DEVS)

Agenda

Session TMS_2B 1330 – 1500 Room: Edison F Session Chair: Feng Gu

- *Instrumentation and Preservation of Extra-Functional Properties of Simulink Models* (Joachim Denil, Hany Kashif, Pansy Arafa, Hans Vangheluwe and Sebastian Fischmeister)
- *Dimension Reduction in Statistical Simulation of Digital Circuits* (Armin Alaghi and John P. Hayes)
- *Levelized Compiled Code Multi-Delay Logic Simulation* (Peter Maurer)

Session TMS_3B 1530 – 1700 Room: Edison F Session Chair: Hans Vangheluwe

- *Mission Critical Publish-Subscribe Performance Modeling using Linear Algebraic and Classical Methods* (Michael Gardner, Cory Beard and Appie Van de Liefvoort)
- *A Modular Representation of Fluid Stochastic Petri Nets* (Fernando Barros)
- *Simulating the Impact of Blind-Spots on the Frequency of Side-Sweep Accidents* (Gamini Bulumulle and Lotzi Bölöni)

Tuesday, 14 April 2015

Sessions TMS

Session TMS_4 1030 – 1200 Room: Edison E Session Chair: Fernando Barros

- *KEYNOTE: What's the Best Possible Speedup Achievable in Distributed Simulation: Amdahl's Law Reconstructed* (Bernard P. Zeigler and James Nutaro)
- *PythonPDEVS: A distributed Parallel DEVS simulator* (Yentl Van Tendeloo and Hans Vangheluwe)

Session TMS_5 1330 – 15:00 Room: Edison E Session Chair: Hessam Sarjoughian

- *DEVS Distributed Parallel Architecture for Enterprise Simulation* (Robert Kewley, Joe McDonnell, Alex MacCalman and Carl Hein)
- *Sequential PDEVS Architecture* (Damian Vicino, Daniella Niyonkuru, Gabriel Wainer and Olivier Dalle)
- *Explicit Modelling of a Parallel DEVS Experimentation Environment* (Simon Van Mierlo, Yentl Van Tendeloo, Sadaf Mustafiz, Bruno Barroca and Hans Vangheluwe)

Symposium on Theory of Modeling & Simulation (TMS/DEVS)

Agenda

Session TMS_6 1530 – 1730

Room: Edison E Session Chair: Joachim Denil

- *A Comparative Study of Pending Event Set Implementations for PDEVS Simulation* (Romain Franceschini, Paul-Antoine Bisgambiglia and Paul Antoine Bisgambiglia)
- *FMI-Based Distributed Multi-Simulation with DACCOSIM* (Virginie Galtier, Stephane Vialle, Cherifa Dad, Jean-Philippe Tavella, Jean-Philippe Lam-Yee-Mui and Gilles Plessis)
- *KEYNOTE: Dynamic Structure Hybrid Systems* (Fernando Barros)

Mod4Sim Workshop

Session M4S_1 1030 - 1200

Room: Edison F Session Chair: Andrea D'Ambrogio

- *On the Integration of HLA and FMI for Supporting Interoperability and Reusability in Distributed Simulation* (Alfredo Garro and Alberto Falcone)
- *Model Transformations for Round-Trip Engineering in Control Deployment Co-Design* (Ken Vanherpen, Joachim Denil, Hans Vangheluwe and Paul De Meulenaere)
- *Model-Based Testing Approach for MATLAB/Simulink using System Entity Structure and Experimental Frames* (Artur Schmidt, Umut Durak, Christoph Rasch and Thorsten Pawletta)

Session M4S_2 1330 - 1500

Room: Edison F Session Chair: Umut Durak

- *Improving the Flexibility of Simulation Modeling with Aspects* (Priyasree Bhowmik, Nathaniel Osgood and Christopher Dutchyn)
- *Generation of an Optimised Master Algorithm for FMI Co-simulation* (KeBert Van Acker, Joachim Denil, Hans Vangheluwe and Paul De Meulenaere)
- *A Model-driven Framework for Distributed Simulation of Autonomous Systems* (Paolo Bocciarelli, Andrea D'Ambrogio, Andrea Giglio and Emiliano Paglia)

Session M4S_3 1530 – 1610

Room: Edison F Session Chair: Andrea D'Ambrogio

- *Automatic Generation of Simulation Models for Early Stage Evaluation of Physical System Topologies* (Josef Müller and Klaas Gadeyne)
- *Automatic Simulation Model Generation in the Context of Micro Manufacturing* (Michael Lütjen, Daniel Rippel and Michael Freitag)

Symposium on Theory of Modeling & Simulation (TMS/DEVS)

Agenda

Wednesday, 15 April 2015

Session TMS_WIP 1030 – 1210

Room: Edison E

Session Chair: Xiaolin Hu

- *Combining DEVS with Multi-agent Concepts to Design and Simulate Multi-models of Complex Systems (WIP)* (Benjamin Camus, Christine Bourjot and Vincent Chevrier)
- *Building Partitioning Graphs in Parallel-DEVS Context for Parallel Simulations (WIP)* (Christopher Herbez, Eric Ramat and Gauthier Quesnel)
- *Activity Diagrams for DEVS Models: A Case Study Modeling Health Care Behavior (WIP)* (Özgür Özmen and James Nutaro)
- *Simulating Information Diffusion in a Multidimensional Social Network Using the DEVS Formalism (WIP)* (Youssef Bouanan, Mathilde Forestier, Judicael Ribault, Gregory Zacharewicz and Bruno Vallespir)
- *Promoting Good Modeling Practice with a Domain-Specific Language and Statistical Algorithms designed for Parallel Computing (WIP)* (Benoit Bayol, Yuting Chen, Charlotte Baey, Gautier Viaud and Paul-Henry Cournede)

23rd High Performance Computing Symposia (HPC)

Agenda

Monday, 13 April 2015

Session I 1030 – 1200 Room: Edison C Session Chair: Layne Watson

- *HPC Best Paper : Performance Analysis and Design of a Hessenberg Reduction using Stabilized Blocked Elementary Transformations for New Architectures (Khairul Kabir, Azzam Haidar, Stan Tomov and Jack Dongarra)*
- *Parallel QR Algorithm for the C-Method: Application to the Diffraction by Gratings and Rough Surfaces (Cihui Pan, Nahid Emad and Richard Dusséaux)*
- *Fast Sparse Matrix Multiplication on GPU (Lukas Polok, Viorela Ila and Pavel Smrz)*

Session II 1330 – 1500 Room: Edison C Session Chair: Phillip Hammonds

- *Shared-Memory Parallelization of the Semi-Ordered Fast Iterative Method (Josef Weinbub, Florian Dang, Tor Gillberg and Siegfried Selberherr)*
- *Towards a More Fault Resilient Multigrid Solver (Jon Calhoun, Luke Olson, Marc Snir and William Gropp)*
- *Accelerating the LOBPCG Method on GPUs using a Blocked Sparse Matrix Vector Product (Hartwig Anzt, Stanimire Tomov and Jack Dongarra)*

Session III 1530 – 1730 Room: Edison C Session Chair: Masha Sosonkina

- *Solving the Klein-Gordon equation using Fourier spectral methods: A benchmark test for computer performance (Samar Aseeri, Oleg Batrashev, Matteo Icardi, Brian Leu, Ning Ning, Albert Liu, Benson Muite, Eike Mueller, Michael Quell, Harald Servat, Parth Sheth, Robert Speck, Mark Van Moer and Jerome Vienne)*
- *TUTORIAL: Productive Parallel Programming with Charm++ (Phil Miller)*

Tuesday, 14 April 2015

Session IV 1030 – 1200 Room: Edison C Session Chair: Josef Weinbub

- *A Research Framework for Exascale Simulations of Distributed Virtual World Environments on High Performance Computing (HPC) Clusters (Amit Goel, William Rivera, Peter Kincaid and Neal Finkstein)*
- *Long-time Simulation of Calcium Induced Calcium Release In A Heart Cell using Finite Element Method on a Hybrid CPU/GPU Node (Xuan Huang and Matthias Gobbert)*
- *PerDome: A Performance Model for Heterogeneous Computing Systems (Li Tang, Xiaobo Sharon Hu and Richard F. Barrett)*

Session V 13:30 – 15:00 Room: Edison C Session Chair: Layne Watson

- *A Self-Adaptive Method for Frequent Pattern Mining using a CPU-GPU Hybrid Model (Lan Vu and Gita Alaghband)*

23rd High Performance Computing Symposia (HPC)

Agenda

- *A Virtual Machine Model for Accelerating Relational Database Joins using a General Purpose GPU (Kevin Angstadt and Ed Harcourt)*
- *Parallel Performance of Higher-Order Methods on GPU Hardware (Tyler Spilhaus, Jared Buckley and Gaurav Khanna)*

Session VI 1530 – 1730

Room: Edison C

Session Chair: Masha Sosonkina

- *A study of manycore shared Memory Architecture as a way to build SOC applications (Yosi Ben Asher, Yousef Shajrawi, Yacov Gendel, Gadi Haber and Oren Segal)*
- *Sharer Status-Based Caching in tiled Multiprocessor Systems-on-Chip (Preethi Parayil Manam Damodaran, Aurang Zaib, Thomas Wild, Stefan Wallentowitz and Andreas Herkersdorf)*
- *A Load Balancing Parallel Method for Frequent Pattern Mining on Multi-core Cluster (Lan Vu and Gita Alaghband)*
- *Exploiting Computing Power of Xeon and Intel Xeon Phi for a Molecular Dynamics Application (Benny Mathew, Nitin Rai, Apaar Gupta and Amit Harode)*

23rd High Performance Computing Symposia (HPC)

Agenda

Wednesday, 15 April 2015

Session VII 1030 – 1200 Room: Edison C Session Chair: Masha Sosonkina

- *Throughput Studies on an InfiniBand Interconnect via All-to-All Communications* (Nil Mistry, Jordan Ramsey, Benjamin Wiley, Jackie Yanchuck, Xuan Huang and Matthias Gobbert)
- *Fast Parallel Conversion of Edge List to Adjacency List for Large-Scale Graphs* (Shaikh Arifuzzaman and Maleq Khan)
- *ExaShark: A Scalable Hybrid Array Kit for Exascale Simulation* (Imen Chakroun, Tom Vander Aa, Bruno De Fraine, Tom Haber, Roel Wuyts and Wolfgang Demeuter)

Session VIII 1330 – 1500 Room: Edison C Session Chair: Will Thacker

- *Efficient Scaling of a Hydrodynamics Simulation Using Compiler-based Accelerator Technology* (Jordan Bradshaw, Behzad Torkian and Philip Moore)
- *Incremental, Distributed Single-Linkage Hierarchical Clustering Algorithm Using MapReduce* (Chen Jin, William Hendrix, Zhengzhang Chen, Ankit Agrawal and Alok Choudhary)
- *Computational Steering for High Performance Computing Applications on Blue Gene/Q System* (Bob Danani and Bruce D'Amora)

Session IX 1530 – 1730 Room: Edison C Session Chair: Layne Watson

- *DOEE: Dynamic Optimization framework for better Energy Efficiency* (Jawad Haj-Yihia, Ahmad Yasin and Yosi Ben-Asher)
- *Predicting Energy Consumption Relevant Indicators of Strong Scaling HPC Applications for Different Compute Resource Configurations* (Hayk Shoukourian, Torsten Wilde, Axel Auweter, Arndt Bode and Daniele Tafani)
- *Efficient Algorithms for Improving the Performance of Read Operations in Distributed File System* (Lakshmi Siva Rama Krishna Talluri, Ragunathan Thirumalaisamy and Sudheer Kumar Battula)
- *High Performance Kirchhoff Pre-Stack Depth Migration on Hadoop* (Chao Li, Yida Wang, Haihua Yan, Changhai Zhao and Jianlei Zhang)

Notes

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Agenda

Monday, 13 April 2015

Session I 1030 – 1200 Room: Banneker Chair: Shajay Bhooshan

- SimAUD Welcome
- SimAUD Keynote: *Stochasticity in Building and Urban Simulation* (Darren Robinson)
- SimAUD Best Paper: *Simulating Human Behavior in not-yet Built Environments by Means of Event-based Narratives* (Davide Schaumann, Yehuda E. Kalay, Seung Wan Hong and Davide Simeone)

Session II 1330 – 1500 Room: Banneker Chair: Rhys Goldstein

- *Capturing an Architectural Knowledge Base Utilizing Rules Engine Integration for Energy and Environmental Simulations* (Holly T. Ferguson, Charles F. Vardeman II and Aimee P. C. Buccellato)
- *Digital Campus Innovation Project: Integration of Building Information Modelling with Building Performance Simulation and Building Diagnostics* (Zixiao Shi, Aly Abdelalim, William O'Brien, Ramtin Attar, Peter Akiki, Katie Graham, Barbara Van Waarden, Steve Fai, Alex Tessier and Azam Khan)
- *Forensically Discovering Simulation Feedback Knowledge from a Campus Energy Information System* (Clayton Miller and Arno Schlueter)

Session III 1530 – 1730 Room: Banneker Chair: Stylianos Dritsas

- SimAUD Outstanding Paper: *Multi-Objective Optimization of Structure and Visual Qualities* (Kirk Martini)
- *Decomposition Strategies for Building Envelope Design Optimization Problems* (Steve Barg, Forest Flager and Martin Fischer)
- *Optimizing Creatively in Multi-Objective Optimization* (Yassin Ashour and Branko Kolarevic)
- *A Multi Agent Systems for Design Simulation Framework: Experiments with Virtual Physical Social Feedback for Architecture* (David Jason Gerber, Evangelos Pantazis, Arsalan Heydarian and Leandro Marcolino)

Tuesday, 14 April 2015

Session IV 1030 – 1200 Room: Banneker Chair: Darren Robinson

- *Exploratory Sequential Data Analysis for Multi-Agent Occupancy Simulation Results* (Simon Breslav, Rhys Goldstein, Azam Khan and Kasper Hornbæk)
- *Occupant-Aware Indoor Monitoring for Enhanced Building Analysis* (Dimosthenis Ioannidis, Stelios Krinidis, Anastasios Drosou, Dimitrios Tzovaras and Spiridon Likothanassis)

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Agenda

- *A System for Tracking and Visualizing Social Interactions in a Collaborative Work Environment* (Mani Williams, Jane Burry, Asha Rao and Nathan Williams)
- *((MODYPLAN)) - Early-Stage Hospital Simulation with Emphasis on Cross-Clinical Treatment Chains* (Gabriel Wurzer, Wolfgang E. Lorenz, Matthias Rössler, Irene Hafner, Niki Popper and Barbara Glock)

Session V

1330– 1500

Room: Banneker

Chair: David Gerber

- *SimAUD Outstanding Paper: Multi-Objective Genetic Algorithms for the Minimisation of the Life Cycle Carbon Footprint and Life Cycle Cost of the Refurbishment of a Residential Complex`s Envelope: A Case Study* (Yair Schwartz, Rokia Raslan and Dejan Mumovic)
- *Optimization of Passive Cooling Control Thresholds with GenOpt and EnergyPlus* (Alexandra R. Rempel and Stephen J. Remington)
- *Toward Pre-Simulated Guidelines for Low-Energy High-Rise Residential Design in Megacities* (Holly Samuelson, Apoorv Goyal, Sebastian Claussnitzer, Alejandra Romo-Castillo, Yujiao Chen and Arpan Bakshi)

Session VI

1530– 1700

Room: Banneker

Chair: Ramtin Attar

- *A Digital Design and Fabrication Library* (Stylianios Dritsas)
- *Aware Design Models* (Martin Tamke)
- *Curve-Folded Form-Work for Cast, Compressive Skeletons* (Shajay Bhooshan, Vishu Bhooshan, Ashwin Shah, Henry Louth and David Reeves)

Wednesday, 15 April 2015

Session E1

0830 – 1000

Room: Banneker

Chair: Alexandra Rempel

- *A Physical and Numerical Simulation Strategy to Understand the Impact of the Dynamics in Air for the Design of Porous Screens* (Mani Williams, Rafael Moya, Daniel Prohasky, Mehrnoush Latifi Khorasgani, Simon Watkins, Mark Burry, Jane Burry and Philip Belesky)
- *Assessing the Energy and IAQ Potential of Dynamic Minimum Ventilation Rate Strategies in Offices* (César Porras-Amores and Spencer Dutton)
- *A Comparative Study of Mixed Mode Simulation Methods: Approaches in Research and Practice* (Priya Gandhi, Gail Brager and Spencer Dutton)

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Agenda

Session VII 1030 – 1200 Room: Banneker Chair: Alejandra Romo-Castillo

- *A New Approach to Modeling Frit Patterns for Daylight Simulation (Mostapha Sadeghipour Roudsari and Anne Waelkens)*
- *Remote Solving: A Methodological Shift in Collaborative Building Design and Analysis (Matthew Naugle and Mostapha Sadeghipour Roudsari)*
- *SimAUD Outstanding Paper: ComfortCover: A Novel Method for the Design of Outdoor Shade (Christopher Mackey, Mostapha Sadeghipour Roudsari and Panagiotis Samaras)*

Session VIII 1330 – 1500 Room: Banneker Chair: Angelos Chronis

- *Simulating Human Visual Experience in Stadiums (Roland Hudson and Michael Westlake)*
- *Self-Organizing City: Experiments using Multi-Agent Model and Space Syntax (Ming Tang)*
- *Computing Curved-Folded Tessellations through Straight-Folding Approximation (Suryansh Chandra, Axel Körner, Antiopi Koronaki, Rachelle Spiteri, Radhika Amin, Samidha Kowli and Michael Weinstein)*

Session IX 1530 – 1700 Room: Banneker Chair: Azam Khan

- *Analyzing Indoor Comfort Conditions through Simulation and On-Site Measurements (Raghuram Sunnam, Annie Marston, Zhuzhou Fu and Oliver Baumann)*
- *Approaching Biomimetics: Optimization of Resource Use in Buildings using a System Dynamics Modeling Tool (Mercedes Garcia-Holguera, Grant Clark, Aaron Sprecher and Susan Gaskin)*
- *Development of a Modeling Strategy for Adaptive Multifunctional Solar Energy Building Envelope Systems (Nicholas Novelli, Justin Shultz and Anna Dyson)*

Modeling and Simulation in Medicine (MSM)

Agenda

Monday, 13 April 2015

Session I **1030 – 1200** **Room: Whitney** **Chair: Jerzy Rozenblit**

TOPIC: Modeling frameworks and data analytics in healthcare

- *Models in Healthcare Simulation: Typology and Security Issues (Jerzy Rozenblit and Johannes Sametinger)*
- *Modeling Clinical Data from Publications (Jacob Barhak)*
- *Rule-Based Modelling and Simulation of Drug-Administration Policies (Luca Bortolussi, Thilo Krüger, Thorsten Lehr, Verena Wolf)*

Session II **1330 – 1500** **Room: Whitney** **Chair: Johannes Sametinger**

TOPIC: Improving Clinical Outcomes Through Simulation

- *Reducing Length of Stay of Patients in an Outpatient OB Clinic - A Simulation Approach (Hari Eswaran, Curtis Lowery, Brandon McVay, Camille Dollins, R.B. Lenin)*
- *Simulating the Expected Net Benefits of Health Research: The Case of Randomized Clinical Trials for Comparing the Effects of Two Health Interventions (Ismail Abbas)*
- *Interactive Multi-Physics Simulation for Endodontic Treatment (Sebastian von Mammen, Marco Weber, Hans-Heinrich Opel, Timothy Davison)*

Session III **1530 – 1700** **Room: Whitney** **Chair: Jacob Barhak**

TOPIC: M&S in Surgical Training

- *Haptic Guidance with Fuzzy Control in Simulation-Based Surgical Training (Minsik Hong and Jerzy Rozenblit)*
- *Novel Force Feedback Interface for Improving Human Perception in Laparoscopic Surgical Trainer (Jan Nikodem and Ryszard Klempous)*
- *Simplex-Based Surface and Contour Models for Segmentation and Meshing for Surgery Simulation (Michel Audette, Rabia Haq, Tanweer Rashid, Sharmin Sultana)*

Work In Process (WIP)

Agenda

Tuesday, 14 April 2015

Session I 1030 – 1200 Room: Whitney Chair: Gregory Zacharewicz

- *The Use of Mathematical Models for Logistics Systems Analysis (WIP)* (Baiba Zvirgzdina)
- *Result Validation Method with Small Sample or Expert Information (WIP)* (Ming Yang, Xiaochao Qian and Wei Li)
- *Modeling Dynamic Sequences in Anylogic for the Purpose of FMS Scheduling (WIP)* (Dusan Sormaz and Subhabrata Ghosal)
- *Combined Linear Regression Models (WIP)* (E. L. Perry, Fortune Mhlanga and Robert Kirchner)

Session II 1330 – 1500 Room: Whitney Chair: Gregory Zacharewicz

- *Population Modeling by Examples (WIP)* (Olaf Dammann, Sergey Nuzhdin, Jacob Barhak, Atesmachew Hailegiorgis, Shweta Bansal, Steve Leff, Joshua Behr, C. Anthony Hunt, Talitha Feenstra, Madhav Marathe, Mary Butler, Bradley Davidson, Paul Marjoram, Stefan Scholz, Jonathan Karnon, Aaron Garrett, Wojciech Chrosny, Samarth Swarup, Naren Ramakrishnan and Cristina Lanzas)
- *Integrating a Formal Requirements Modeling Simulator and an Autonomy Software Simulator to Validate the Behavior of Unmanned Vehicles (WIP)* (Elizabeth Leonard, Constance Heitmeyer and Valerie Chen)
- *An Integrated Software Environment of Simulation Experiment Design, Analysis and Evaluation (WIP)* (Wei Li, Lingyun Lu, Ping Ma, Ming Yang and Zhizhao Liu)
- *Study of Optimizing Fuel Tank Volume of Fast Combat Support Ship for Marine Operations during Wartime (WIP)* Chungman Seo and Chungwoo Lee

Session III 1530 – 1650 Room: Whitney Chair: Gregory Zacharewicz

- *Synthetic Data Generation for High-Fidelity HPC Healthcare Simulation: Beneficiary-Provider Network Example (WIP)* (Gautam S. Thakur, Byung H. Park, Özgür Özmen, Jack Schryver, Mallikarjun Shankar and Gilbert G. Weigand)
- *Approach to Reachability Analysis of Finite and Deterministic DEVS Models (WIP)* (Hae Young Lee)
- *Validation of System of Systems Emergent Behavior Through Modeling and Simulation (WIP)* (Mary Ann Cummings)
- *Probabilistic Modelling of GPS-based Capabilities (WIP)* (Vaughn Standley, Edward Boucheron, Robert Kirkwood and Benjamin Norman)

Poster Session/Student Colloquium/Mobile App

Agenda

Sunday, 12 April 2015

Session I (Poster/Colloquium) 0900 – 1015

Room: Edison EF

Session Chair: Salim Chemlal

- *Convergence of Linear Algebraic Reliability Simulation* (Seth Henry, Christopher Griffin and Paul Bruhn)
- *Distributed Recommender System for Online Processing of Big Social Data* (Lubaid Ahmed and Abdolreza Abhari)
- *Energy-Efficient Structures: Visualizing Environmental Performance of Structural Building Material* (Matan Mayer)
- *Integrating Computational Fluid Dynamics with Preliminary Architectural Design for Natural Ventilation* (Shan He and Ulrike Passe)

Session II (Poster/Colloquium) 1045 – 1210

Room: Edison EF

Session Chair: Salim Chemlal

- *Iterative Simulation-Optimization of a Multi-State Manufacturing System* (Mohammad Dehghani-mohammadabadi and Thomas Keyser)
- *Modeling Interoperability between a Reflex and Reasoning System in a Physical Simulation Environment* (Konner Atkin, John Licato and Selmer Bringsjord)
- *Simulation Approach to Support Sustainability of Higher Education* (Anatoly Kurkovsky)
- *Web-In-The-Loop Simulation Framework for Supporting Cors-Based Development* (E Jin Kim and Hae Young Lee)
- *Simulation Exploration Experience (SEE)*

Session I (Mobile App)

1330 – 1500

Room: Edison EF

Session Chair: Salim Chemlal

- *3D Interactive Massage App* (Yuzhong Yu, Shuo Ren and Zelin Zhu)
- *Alumni Connect at JMU* (James Fencil, Connor Major, Robert Bolen and Samy El-Tawab)
- *Devsimpy-Mob : Management of Ubiquitous Systems with a Mobile Application Using Discrete Event Simulations* (Timothée Ville, Souhila Sehili, Laurent Capocchi and Jean-François Santucci)
- *Disaster Ambulance Decision Support System (DADSS)* (Yu-Hsuan Lin, Shao-Jen Weng, Yeong-Yuh Xu, Tzu-Chian Chen, Kathleen Aprillia, Yu-Zhe Shi, Ling-Ling Li and Hsing-Yi Tsai)
- *Healthcare Network Decision Support System (HNDSS)* (Yu-Hsuan Lin, Shao-Jen Weng, Yeong-Yuh Xu, Tzu-Chian Chen, Kathleen Aprillia, Yu-Zhe Shi, Ling-Ling Li, Hsing-Yi Tsai, Wei-Ming Wu, Hong-Hsun Chen and Jhe-Kai Lin)

Poster Session/Student Colloquium/Mobile App

Agenda

Session II (Mobile App) 1530 – 1715

Room: Edison EF

Session Chair: Salim Chemlal

- *Mobile Application for Objective Measurement of Pectus Excavatum Vacuum Bell Treatment* (Nahom Kidane, Salim Chemlal, Mohammad Obeid, Krzysztof Rechowicz, Frederic McKenzie and Robert Kelly)
- *Mobile Simulation: Bringing Simulations to Smartphones* (Mohammad Etemad, Sixuan Wang and Gabriel Wainer)
- *Park @ JMU* (Dave Faliskie, Bradley White and Samy El-Tawab)
- *Real-Time ECG Rendering on Mobile Devices for Ecg-Based Virtual Pathology Stethoscope Tracking* (Christopher Bliss, Dimitry Jacquet, Marvin Walker, Michael Kilmartin, Christopher Venning, Nahom Kidane, Salim Chemlal and Frederic McKenzie)
- *Roger Williams University PhysAssist* (Brian Lee, Mark Fesenmeyer, Danielle Roche and Kevin Oliveira)
- *Virtual Reality Interaction Using Mobile Devices* (Sahar Aseeri, Daniel Acevedo-Feliz and Jurgen Schulze)

Session III (Poster/Colloquium) 1745 – 1830

Room: Edison EF

Session Chair: Salim Chemlal

- *POSTER PRESENTATIONS: Regular Posters and Student Posters*

1830: Networking and Social Activity for Poster/Colloquium & App Competition Participants

**Location: Delia's Mediterranean Grill & Brick Oven Pizza, 209 Swamp Fox Rd.
Alexandria, VA 22314**

Notes

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ABSTRACTS

Impacts of Market Behavior on Distributed Energy: A Multi-Disciplinary, Hybridized Modeling and Simulation Approach

Solomon Sherfey, Andrew Collins, Paul Moses and Sylvain Marsillac

Summary
Renewable energy sources such as wind, solar and micro-hydro have significantly advanced in recent years. They are more efficient, more easily acquired by the general public, and increasingly more economically feasible as energy alternatives. As their penetration into the energy marketplace increases, they present both potential complications for the management of the energy distribution system as well as potential benefits. Previous studies are largely a “top down” analysis of methods to cope with presumed behavior, on an aggregate basis, of the energy consumers. This paper outlines a proposed hybrid simulation system, using both agent-based and systems dynamics simulation techniques to examine the impacts of consumer behavior on the energy system from the “bottom up.” By combining a system model of the electrical energy infrastructure with a heterogeneous consumer model, our simulation is designed to provide output to aid the development of new energy policies.

Agent-based Pedestrian Evacuation Modeling: A One-Size Fits all Approach?

Andrew Collins, Erika Frydenlund, Terra Elize and Michael Robinson

Summary
Past studies develop pedestrian simulations with a large number of agents to answer a series of different questions including estimating the evacuation times from a building or event. This development has occurred due to the advancement of computer and simulation. The advancement in technology also allows us to demand more from our simulations beyond the homogeneous unconnected behavior seen in older simulations. For example, the group dynamic affects the pedestrian movement, such as a parent’s unwillingness to navigate through a crowd without consideration for their child. Agent-based modeling and simulation (ABMS) provides an excellent tool to incorporate groups into a pedestrian model. However, there are several ABMS platforms available for selection. In this paper, the authors developed two independent pedestrian models that incorporate groups, using two different ABMS platforms: Repast Symphony and NetLogo. The paper compares the two simulation results and concludes with a discussion on model selection.

Agent-based Simulation for Assessing Network Security Risk due to Unauthorized Hardware

Neal Wagner, Richard Lippmann, Michael Winterrose, James Riordan, Tamara Yu and William Streilein

Summary
Computer networks are present throughout all sectors of our critical infrastructure and these networks are under a constant threat of cyber attack. One prevalent computer network threat takes advantage of unauthorized, and thus insecure, hardware on a network. This paper presents a prototype simulation system for network risk assessment that is intended for use by administrators to simulate and evaluate varying network environments and attacker/defender scenarios with respect to authorized and unauthorized hardware. The system is built on the agent-based modeling paradigm and captures emergent system dynamics that result from the interactions of multiple network agents including regular and administrator users, attackers, and defenders in a network environment. The agent-based system produces both metrics and visualizations that provide insights into network security risk and serve to guide the search for efficient policies and controls to protect a network from attacks related to unauthorized hardware. The simulation model is unique in the current literature both for its network threat model and its visualized agent-based approach. We demonstrate the model via a case study that evaluates risk for several candidate security policies on a representative computer network.

Reward-Selective Propagation Cascade Model

Yu Zhang and Tyler Olson

Summary
In the field of network diffusion, the traditional Independent Cascade Model and Linear Threshold Model give activated nodes the opportunity to influence and potentially activate each of its neighboring inactive nodes, regardless of the level of influential weight or probability of activation. This paper extends the Independent Cascade Model to be selective in terms of influencing neighboring nodes. We introduce the Reward-Selective Propagation Cascade Model, a diffusion model that allows active nodes to select neighbors based on the potential payoff from the existing relationship between the two nodes. We provide a polynomial algorithm for calculating the payoff value for any arbitrary relationship between two neighboring nodes in a network graph, and a function to calculate the weight of each edge in an arbitrary graphical setting. Finally, we perform both an analysis of the RSPCM under different network settings, and a comparative examination with the classic Independent Cascade Model. This research makes contributions to the domain of informational diffusion and sociological propagation.

Agent-Directed Simulation (ADS)

Abstract

An Agent-based Approach to Modeling Insider Threat

John Sokolowski and Catherine Banks

Summary

Insider threat research and modeling has focused on the individual and the prediction of an insider threat incident. The majority of these models are statistical with inputs from psychological and social (work environment) assessments. These statistical analyses tend toward trend-projections using various regression models. The modeling presented in this paper implements the agent-based paradigm that is designed to explore the primary elements of an insider threat. Specifically, the insider (represented as an agent) interacts with other employees and the organization (also represented as agents) in an environment that provides the opportunity and necessary access to become an insider threat. The specific research question we seek to answer is “How and when does an insider that is pre-disposed to being a threat make the decision to become an active insider threat?” The model met the research objective: capture insider threat behavior given the set of assumptions governing agent behavior.

Examining Norm Establishment and Spread In Different Organizational Structures Using an Extended Axelrod Model

Meghendra Singh and Vivek Balaraman

Summary

All organizations have structure which is a compound of many structural dimensions, size, span of control and the nature of the hierarchy such as flat or tall. The structural form of organizations is usually decided by its function and maturity. Thus startups tend to be flat, with few levels but high span of control while more established organizations tend to have many levels and fewer people reporting into each person. There are also bottom heavy organizations such as in call centres whose workforce are concentrated in the bottom-most layer. A question of interest is to see how norms establish and percolate across different forms of organizational structures. In this paper we use an extended Axelrod model to study this question. We build upon our earlier work where we studied norms establishment in a single team in an organization. In this paper, we examine how organizationally mandated norms percolate through different types of organizational structures for varying initial values of the two norms variables Conformity and Vengefulness. We show how Flat Dense Organizations (few levels, high span of control) are able to maintain ideal norm states at lower levels even though higher levels may have lower Conformity or Vengefulness while in Tall Sparse Organizations (many levels, low span of control) norm collapse at higher levels quickly leads to norm collapse in the lower levels. Bottom Heavy Organizations demonstrate behaviour which is intermediate to these two. We also examine how visibility moderates norm establishment and show that FDO is least affected, TSO the most with BHO lying in between.

An Agent-based Model to Simulate Farmer Decision Process

Kasi Bharath Vegesana

Summary

This paper presents an implementation of a mathematical model for simulating farmer decision processes. It is an Agent Based process that utilizes ‘IF – THEN’ rules in a Fuzzy Logic System, and integer programming. This model was applied on Farm Accountancy and Data Network (FADN) data for Piedmonte, Italy. We will examine the design process in detail, and evaluate our initial results. Finally, we will discuss limitations and future applications of the model

Synchronising Agent Populations When Combining Agent-Based Simulations

Bhagya Niroshan Wickramasinghe, Dharendra Singh and Lin Padgham

Summary

In this paper we systematically investigate the problem of integrating two agent-based simulations (ABMs) that conceptually model the same agent population. The set up progressively steps the two simulations via an external controller, and synchronises the agent populations at the end of each step in such a way that they remain equivalent. Synchronisation involves changes to state variables only inside each simulation, resulting in additions and deletions to the list of agents, to agent properties, and to their relationships to each other. The key challenge is to ensure that the both the underlying simulations as well as the global simulation are always in a logically consistent and meaningful state. We present a conceptual framework to discuss these issues and solutions, in the context of integrating two substantially complex ABMs from literature. Our integration approach guarantees that the validated logic of the participating simulations is preserved.

Agent-Directed Simulation (ADS)

Abstract

Defining Behavior Of Computational Agents Based On Military Doctrine

Alexandre de Menezes Villarmosa, Gustavo Henrique Soares de Oliveira Lyrio and Roberto de Beauclair Seixas

Summary

Since the beginning of nineteenth century combat simulations are used in military training. It's necessary to involve lots of military to these trainings occur reliably. In the late 1940s the idea of computational agents was developed in artificial intelligence and showed as an excellent tool to reduce the amount of personnel involved in combat simulations. Agents perceive the environment where they are inserted and take actions upon it following a set of rules. That reminds the behavior of a soldier. A soldier, or a group of them, perceive the battlefield and take a series of actions based on military doctrine. Therefore, the scope of this work is to present a viable way to define the behavior of computational agents based on military doctrine, so that they can replace some of the personnel involved in a combat simulation without affecting the reliability of the training in course. In addition making more efficient simulation systems, reducing the amount of required military for its proper implementation, can also help to check the logical consistency of the actions planned in the doctrinal manuals. In this paper you will find a introduction about military training followed by the conceptual description of computational agents and how it was modeled, passing by the basis of military doctrine and its modeling, passing by a case study until reach our conclusions.

A Graph-Based Agent-Oriented Model for Building Occupancy Simulation

Sanish Rai, Minghao Wang and Xiaolin Hu

Summary

A building occupancy simulation simulates the behavior of the occupants and assists in recognizing occupant's behavior which can be used in energy consumption, smart assist as well as in emergency evacuation. Agent based models are widely used to represent the occupants but suffer poorly due to increase in computation cost with the increase in agents. Graph based and cellular approaches are used to simulate large mass of occupants, but they treat the occupants as a homogeneous mass and thus the emergent behavior due to individuality is lost in the model. This paper recognizes the limitations of the existing models that deals with the building occupancy simulation and aims to combine the benefits of agent and graph-based modeling to come up with a rational and effective way of building occupancy simulation. This model departs from the existing ones through a difference in a way occupants are treated. The model sees them as entities having their own properties and decision making abilities rather than treating them as a group. This enables the model to handle evacuation systems in places with considerably larger amount of occupants like stadiums and concert arenas. As a case study, we conducted a simulation of emergency evacuation in a certain building with a selected type of agents using our model. The results demonstrate the feasibility of the proposed method, as well as the potential of simulating large mass of occupants within reasonable computational resources.

Creating and Reasoning Over Scene Descriptions in a Physically Realistic Simulation

Nicholas Marton, John Licato and Selmer Bringsjord

Summary

Physical awareness is typically taken to be a prerequisite for human-level performance of any agent in a physical environment. In order to perform basic planning and navigation, such an agent must have the ability to assess, represent, and describe aspects of a physical scene, so that relevant reasoning can then be carried out. We describe our framework for this assessment-to-reasoning sequence of tasks, and show how a description of a physical scene can be obtained by an agent that only has direct access to sensory-level information about the world it inhabits (the simulation environment PAGI World), and how that agent can integrate this knowledge with an analogico-deductive reasoner (ADR).

48th Annual Simulation Symposium (ANSS)

Abstract

Assessing Personality Traits of Simulation-Based Training Scenario Developers

Stephanie Lackey, Crystal Maraj and Julie Salcedo

Summary

The U.S. military uses Simulation-Based Training (SBT) to aid Soldiers in preparing for combat. A vital part of the SBT cycle involves scenario development. Scenario developers utilize software tools to create visual and auditory representations within a Virtual Environment (VE). Software applications such as Virtual Battlespace 2 (VBS2) and CryENGINE®3 represent simulation systems employed by the U.S. Armed Forces and serve as the platforms in the research presented. The following experiment investigated the relationship between user characteristics and scenario development performance outcomes. Thirty participants performed a set of pre-defined tasks including placing objects and altering scene settings. In addition to accuracy scores and response times, subjective data were also collected. The International Personality Inventory Pool (IPIP) questionnaire assessed personality traits of the participants. In addition to analyzing correlations between variables, a series of multiple linear regressions using the IPIP subscale predicted accuracy scores and response times. The results offer insight into personality traits that inform selection criteria for SBT scenario developers.

A Tool for Model Conversion Between Simulators of Grid Computing

Gabriel Covello Furlanetto, Rafael de Souza Stabile, Renata Spolon Lobato, Aleardo Manacero, Roberta Spolon and Denison Menezes

Summary

High performance computing systems usually have a high usage cost, even with the use of shared systems, such as grids and clouds. To reduce such costs it is necessary to optimize system's utilization through performance analysis of one's application. This can be done through simulators designed specifically for performance prediction/analysis, such as GridSim and Simgrid, among several grid computing simulators developed in the past years. Unfortunately, there is no compatibility between these simulators, making models developed for one of them unusable for the others. This is even more problematic when one notices that the models for these simulators demand coding of several complex functions, making model reuse hard to achieve. In this paper we present an extension made to iSPD (iconic Simulator of Parallel and Distributed Systems), which is already an easy-to-use grid simulator, in order to enable model conversions. With this extension one user is able to read models written for GridSim or Simgrid, converting them into the iconic models used by iSPD, as well as to convert iSPD models into models for these simulators. The process of conversion is discussed, showing the actions necessary to convert the models. It is also presented a comparison between the simulation of models built using each simulator.

Simulation Visualization Issues for Users and Customers

Andrew Collins, D'An Knowles Ball and Julia Romberger

Summary

The use of high-end graphics can have a mesmerizing effect on simulation novices and, as such, may blind the user to the actual capabilities and valid usages. The visualization of simulations are distinct from other computer graphic media because they are a representation of an abstract of reality (the model) as opposed to a representation of reality. This paper provides examples of visualization usages that could have a potential negative impact on users' understanding of the simulation. This paper continues on to discuss some of the possible solutions to the issues of poor visual rhetorical choices and provides an aid for non-experts in the form of a "cheat-sheet" designed to allow a non-expert user insight into some visualization problems and tricks. The focus on non-expert users stems from these authors' belief that simulation users, and not the experts, will shape the ultimate future of Modeling and Simulation.

Calculating Grid Partitioning Costs of Distributed Virtual World Simulation Systems

William Rivera and Amit Goel

Summary

Designing high fidelity and scalable distributed virtual environments remains a major challenge. Concurrent users, scene complexity and fidelity of user interaction are affected when computational resources become saturated because of high network traffic and heavy CPU load. Previous work dedicated to dynamic load balancing attempt to solve resource allocation based on avatar count and activity by developing load balancing policies that distribute server load by reassigning avatars to evenly distribute computational load. The efficient assignment of the systems resources based on workload is consider a partitioning problem. Few studies have focused on developing cost models for the partitioning problem beyond avatar position and movement or from real world performance. In our research we have found that there is a difference in performance and CPU load between simulated agents (bots) and actual user controlled agents (avatars) not specifically related to agent count. In this paper we focus on presenting a cost model based on simulator specific factors that impact simulation performance using the Open simulator framework.

Effective Visualization in Modeling & Simulation Daniele Vernon-Bido, Andrew Collins and John Sokolowski

Summary

The visualization aspect of modeling and simulation (M&S) is rarely discussed. The primary concerns are typically model design, statistical probabilities, analysis, and verification and validation. However, visualization is an integral part of the M&S process and provides several opportunities to provide insightful information for developers and users alike. In recent years, discussions on data visualization have arisen including what makes a good visualization. Are these techniques applicable to M&S? In this paper, we outline a basic taxonomy of M&S visualization and discuss the current state and issues faced by each type. The wider field data visualization is also discussed to give context for M&S visualization. The paper concludes with a discussion on way forward for evaluating effective M&S visualization.

An Exploration of Fault Tree Analysis Methods for Military Simulations Jeff Hanes and John Fay

Summary

Fault trees are used to evaluate weaknesses in many types of systems, including military systems. They are frequently used in simulations to link component failure to functional capabilities. This research compares several methods to find the key components that disable fault trees, paying particular attention to minimal cut sets. The methods explored include SAPHIRE, Genetic Algorithms, and Graph Theory. SAPHIRE is a software system developed at the Idaho National Laboratory for the U.S. Nuclear Regulatory Commission. Exhaustive searches are used for small test cases as a means of validating and comparing the other methodologies. The above methods are described and compared for their applicability to evaluating effects on military systems. The results show that genetic algorithms are a promising method to augment weapons effects simulations to find weaknesses in military targets.

Asynchronous Optimization Techniques for Distributed Computing Applications Raphael-Elias Reisch, Jens Weber, Christoph Laroque and Christian Schröder

Summary

Simulation-based optimization of manufacturing systems has emerged into a widely accepted decision support technique for industrial applications. Due to the computational complexity of these applications, simulation-based optimization is typically implemented in software systems that make use of distributed computing-units in order to reach an acceptable performance. However, even then dynamical methods, i.e. methods that are not bound to a fixed number of iterations are desired in order to further increase the performance of the optimization process. This paper addresses possibilities for employing population-based optimization techniques in an asynchronous way in order to react to computational node failures, limited computing resources and unbalanced simulation times. We demonstrate our approach by applying it to the optimization of set-up parameters for virtual tooling machines within an underlying research project of the leading edge cluster 'ITS OWL – intelligent technical systems'.

MOE Quantification of Missions using Sensor Data Driven Graph Similarity Measures Bharat Madan and Doina Bein

Summary

A mission plan consists of a set of actions to be performed in a given situation, such that these actions mitigate the assessed situation effectively. Military missions Intelligence, Reconnaissance and Surveillance sensors with diverse sensing modalities gather massive volume data, which is fused using data fusion model, e.g., Joint Directorate of Laboratories (JDL) model. Level-2 of this model provides situational assessment, which is defined in terms relationships between different objects relevant to the mission context. Using this definition, we model a situation as graph or hyper-graph $G(V,E)$, is a set of vertices V are the objects and E is the set edges which model the relationships between objects allows. A given situation s_k at time k , in which action a_k is performed, changes the new situation to s_{k+1} . Measure of Effectiveness (MOE), which evaluates the effectiveness of actions, is an important metric of the mission performance. The available literature on MOE has mostly utilized different variations of the Lanchester model and Monte Carlo simulations for evaluating the MOE. In this paper, we use the novel technique of quantifying MOE by measuring changes between situations due to mission actions. modeling a situation s_n as a graph G_n , which when represented by its adjacency matrix A_n , enables us apply graph similarity algorithms to measure the differences between A_n and A_m , thus quantifying MOE. Since situation is derived from sensor data, as compared to existing techniques, our approach offers two advantages (i) significantly reduced computations as compared to Monte Carlo techniques, and (ii) its ability to measure situation changes and consequently the MOE, in an online manner. The second feature allows MOE to be quantified from one time epoch to another, which can be used adapt missions dynamically and on line. We use simulations to validate our assertions.

Bayesian Changepoint Detection for Generic Adaptive Simulation Algorithms

Tobias Helms, Oliver Reinhardt and Adelinde M. Uhrmacher

Summary

Adaptive simulation algorithms are used to deal with changing computational demands of simulations due to state changes of the model and the environment. If such an algorithm is developed in a generic manner, i.e., it is not equipped by the developer with a function which decides how to switch its configuration, sophisticated techniques like machine learning need to be exploited. Since adaptations can be costly, it is not practicable to adapt after each simulation step. Consequently, a fundamental challenge of generic adaptive simulation algorithms is to decide when to execute adaptations. For this, we present a dynamic algorithm based on Bayesian online changepoint detection. By observing performance values regularly, this algorithm decides whether adaptations should be executed or not. We evaluate our approach based on a benchmark model defined in PDEVS and a model used in simulation studies defined in ML-Rules. Both modeling formalisms exhibit different dynamics and different requirements for adaptation and thus underline the generality of the adaptation strategy. Altogether, we present how the proposed Bayesian changepoint detection strategy helps balancing the effort required for adaptation, possible speed-up by this adaption, and the effectiveness of the machine learning algorithm.

An Investigation of 'Soft' Operations Research Methods to Inform Hybrid Simulation Studies on Environmental Disasters

Anna Wienke and Navonil Mustafee

Summary

A simulation study involves several distinct stages, such as conceptual model development, model implementation, validation, and experimentation. This paper recognizes the interconnectedness of these stages and the necessity for a conceptual model to be an inclusive portrayal of the real-world system, especially when such a system exists in a multi-stakeholder environment (MSE). The paper focuses on this initial stage of a M&S study, which involves determining the system requirements, and investigates 'soft' operations research (OR) literature in relation to disaster operations management (DOM) and emergency operations research (EOR). Despite the limited use of 'soft' OR techniques in these research domains, the suitability of and need for such qualitative approaches to inform quantitative model building, particularly for decision-support purposes, is established. Furthermore, a multi-methodological 'soft' OR approach, Soft Systems Methodology (SSM) combined with Drama Theory & Confrontational Analysis (DT&CA) for conceptual model development in MSEs, is discussed.

Investigating Execution Strategies for Hybrid Models developed using Multiple M&S Methodologies

Navonil Mustafee, M'Hammed Sahnoun, Andi Smart, Phil Godsiff, David Baudry and Anne Louis

Summary

The complexity of systems and their multi-faceted relationships mean that the combined application of simulation methods, or hybrid simulation, will enable synergies across techniques and will provide greater insights to problem solving. In this paper we present a hybrid simulation case study in which two models have been developed; an Agent-Based Simulation (ABS) and a Discrete-Event Simulation (DES). The models simulate the operations of offshore wind turbines, with the ABS modelling turbine failure (through, among other things, simulating a degradation model of turbine components) and the DES modelling Maintenance, Repair and Operations (MRO) strategies. The models have been implemented in NetLogo and Simul8 respectively. In this paper we review strategies for the interoperation of our hybrid ABS-DES model and discuss the advantages of using the IEEE 1516 HLA standard for distributed simulation for dynamic information exchange and synchronized model execution.

Knowledge Reformulation and Abstraction for Rapid Model and Agent Development

Margery Doyle, Eric Watz and Antoinette Portrey

Summary

Until just recently, a Live Virtual Constructive (LVC) Distributed Missions Operation (DMO) capable agent/model had to be able to reformulate/abstract primitive Distributed Interactive Simulation (DIS) network protocol information into meaningful/actionable high-level state representations for use in gaining situation awareness and or understanding, problem solving, and decision making. Then to take an action, within the simulated environment agents/models had to determine the proper action-set/s to be broken down into a series/sequence of primitive simulation specific network updates to carry out their chosen behaviors. Herein, we examine a recently proven set of architectural design concepts and methods based on the findings of Doyle and Kalish, 2004, that have thus far proven to be capable of offering agents/models various levels of pre-processed precepts, abstractions, and reformulated knowledge representations to support rapid model/agent development and real-time adaptive behavior capabilities for use in LVC DMO training Research. In addition, we will show how a Tactical Observation Agent (TOA) originally developed to support agent/model situation awareness has already proven useful within a Learning Management System (LMS) for a cross-functional purpose. We will provide a descriptive example as to how this new type of architecture supports the functional roles and purposes of various modeling and agent development techniques which span the strata of representation types through the knowledge reformulation and abstraction hierarchy.

48th Annual Simulation Symposium (ANSS)

Abstract

Agent-based System for Simulating the Dynamics of Social Identity Beliefs

M. Afzal Upal and Sarah Gibbon

Summary

In expeditionary environments, Western Military commanders are increasingly being asked to take into account the secondary and tertiary effects of their actions on the “hearts and minds” of the target populations similar to the way that they take the physical/kinetic effects of their actions into account. The problem is that while there are a number of tools that commanders can use to assess physical effects of their kinetic actions (for instance tools exist that can be used to precisely predict the size of a crater resulting from the impact of a missile to be fired from a ship thousands of miles away from the target), commanders have little or no access to computer tools for assessing the human terrain effects of their kinetic and non-kinetic actions, and select the action that is most likely to be effective. Development of human terrain effect assessment tools requires the development of a detailed socio-cognitive theory of social influence. This paper presents a socio-cognitive model based on a synthesis of social identity theory with rational choice theory and social identity entrepreneurship model of leadership. We will also describe how this theory has been translated into an agent-based social simulation system that allows Canadian Armed Forces’ Influence Activities practitioners to understand the impact of various influence operations on the human terrain elements of a target population. The paper will conclude with results from a parameter sweeping analysis of the agent-based social simulation system which offers us new insights into the dynamics of social identity beliefs of two interacting populations.

The Application of Constructive Modeling and Simulation to Teach Port Management

Mariusz Balaban, Sara Russell, Thomas Mastaglio and Paulette Dykes

Summary

Current use of constructive Modeling and Simulation (M&S) to teach port managers skill sets is in large missing. The fast pace of change in the maritime industry requires similar adaptation from teaching institutions. Old Dominion University (ODU) began development of a unique curriculum for a port management undergraduate course that integrates a GIS-based M&S environment with the traditional course curriculum. This paper explores requirements and options for teaching port management aided by constructive M&S. A sample case study based on a real world problem is presented. Additionally, a survey was developed and administered to determine whether utilizing a M&S tool gave students a better understanding of the course material and if they gained additional understanding through such a format as compared to classes where constructive M&S was not used. The results indicate that the use of constructive M&S can aid port management students to develop domain relevant problem solving skills, stimulate creativity, and critical thinking.

Integrating Simulation-driven Decisions and Business Wargames To Shape Fiscal Policies

Alejandro Hernandez

Summary

In 2013 sequestration resulted in defense budgets absorbing the greatest proportion of cutbacks, putting leaders on notice that future debates must be built on more solid cost positions related to operational success. In this paper we use a systems engineering approach to develop a decision support system that integrates operational planning, gaming, computer simulation, and experimentation. The resulting methodology translates strategic budget decisions in terms of military effectiveness. Central to this effort is implementation of a campaign level simulation to adjudicate the impact of budgetary decisions on force effectiveness. Equally important is the transformation of a computer-assisted wargame into a closed-form simulation experiment to examine the trade space of the problem. Policy makers at every level are in dire need of a capability to meet the challenges of austere economic environments. We offer a fiscally-bounded, simulation-based gaming process to provide policy makers with credible options that are quantifiable, repeatable, and analytically defensible.

Generating Domain-specific Simulation Environments from Model Frameworks Based on SMP2 for Rapid Development of Simulation Applications

Ning Zhu, Jian Yao, Yonglin Lei, Weiping Wang and Yifan Zhu

Summary

Operational effectiveness is one of the most important warrants for weapons and equipment systems demonstration and design, and assessing operational effectiveness based on simulation is a key method. Operational effectiveness simulation relies on a large quantity of simulation applications, and composable modeling is an approach to support rapid development of simulation applications. Currently, it is more effective for composable modeling to proceed with simulation models libraries based on a standard simulation modeling specification and constrained by a uniform simulation model framework. A model framework describes all kinds of simulation models and their relationships in a simulation system. However, it is variable before taking shape, and it can be enlarged to describe a larger domain while parts can be extracted from it to describe a more specific domain. So generating simulation environment from a model framework is a more effective method to develop simulation environments and applications. In this paper, model frameworks and simulators are separated according to a specific modeling specification SMP2 (Simulation Modeling Portability Standards 2), and model frameworks contain all the information to describe domain specific knowledge. Then a generic simulation environment is built according to SMP2 and only handles with scheduling models, collecting data and analyzing data. A domain specific environment will be auto generated after a domain-specific model framework is loaded. Finally a UAV system simulation environment generated by a UAV system simulation model framework based on SMP2 is illustrated as an example.

The Multi-craft Problem: A Distributed Simulation Approach Using Networked Floating Objects

Abir Zubayer, Dennis Peters and Brian Veitch

Summary

The multi-craft problem is defined as simulating the interactions of multiple objects floating on water. This encompasses the direct interactions between water and the object, and indirect interactions between objects that occur via the water. Existing solutions generally treat the floating objects as simple 3-dimensional volumes with properties such as weight and buoyancy. For many practical situations, these objects need to be simulated by complex rules. The simulation of ships is a case in point. As realistic water simulation itself is computationally expensive, accommodating the added complexity due to floating objects can be a difficult task. This paper proposes a method for distributed water simulation where the scope of each participating simulation is chosen by the model that governs it. For the multi-craft problem, this means simulating the water in one node and simulating the floating objects in other nodes in a network. Details of a prototype are presented to show how implementation of such a scheme can be achieved. Its effects on modularity, performance, scalability and security are also illustrated.

Estimating the Probability of a Timely Traffic-hazard Warning via Simulation

Nils Müllner, Sibylle Fröschle and Martin Fränzle

Summary

Traffic flow simulation is exploited for estimating the probability, that a message — a hazard warning in this case — is correctly transmitted to an approaching car before overstepping a safety threshold. The results derived by simulation provide valuable insights in the functional relation between the numerous authoritative parameters and the reliability of timely message reception. Despite analyzing safety-critical information flow, the analysis allows to determine weak spots in the communication infrastructure that are relevant to the infrastructure's security.

An Adaptive Fault-tolerance Scheme for Distributed Load Balancing Systems

Dan Liu, Robson Eduardo De Grande and Azzedine Boukerche

Summary

Load balancing of distributed virtual simulations has been developing into a critical mechanism for enabling these simulations as their complexity grows to model more realistic scenarios. As the scale of these systems increases, they become more susceptible to load imbalances caused by the heterogeneity and non-dedication of resources and by their own simulation load oscillations. Due to its importance, many balancing systems have been designed for distributed simulations. Nevertheless, none of the previous systems consider the existence of failures in their own systems, which can partially hamper or completely interrupt their balancing capabilities. Therefore, a fault-tolerant mechanism is introduced for load balancing systems to keep some minimal services running properly or enable the recovery of components when faults unpredictably occur. The proposed solution employs election and grouping tools to reconfigure the balancing system dynamically. Experiments have been conducted in order to evaluate the benefit of the proposed fault-tolerant balancing system.

Abstract

Universal Simulation Engine (USE) - A Model-independent Library for Discrete Event Simulation

Desheng Fu, Matthias Becker and Helena Szczerbicka

Summary

Universal Simulation Engine (USE) is a C++ library providing a model-independent environment for Discrete Event Simulation (DES) tasks. Unlike most simulators, USE focuses on the general simulation technology and integrates many features, which are necessary to build a correct and efficient simulation system. It is aimed at providing a professional environment to reduce the cost of modeling as well as the execution time of the simulation for almost all DES models. Developers may use USE as an open framework to build models very efficiently. USE also supports many advanced features such as Distributed Discrete Event Simulation (DDES), Virtual Environments (VE), Online Simulation (OS), dynamic coupling / decoupling of sub-models, etc. This paper introduces the distinctive features of USE for practical implementation of DES, DDES and VE systems. We also evaluate the performance of USE by comparison with existing simulators.

Model-Based Configuration of Automotive Co-Simulation Scenarios

Martin Krammer, Johannes Fritz and Michael Karner

Summary

Co-simulation represents a state-of-the-art method for virtual integration of automotive systems together with their environment. Due to the increasing number of simulation models representing these systems and their environment the setup of co-simulations becomes time consuming and error-prone. Configuring a co-simulation framework requires detailed information, about both the deployed systems as well as virtual integration specific aspects. This paper takes the idea of a model based co-simulation configuration further, where all necessary information for executing co-simulations is retrieved from a system model. For that purpose a meta-model, a subsequently derived UML-profile and a tool extension are developed. With this approach a tighter integration of simulation based verification activities to model-based systems engineering techniques is achieved. This allows engineers to generate co-simulation configurations out of system models. These co-simulation configurations can be fed directly to the used co-simulation framework, eliminating the need for time consuming configuration of such a framework. Furthermore, potential reuse of entire co-simulation configurations or parts thereof is ensured. To support these claims, use cases from the automotive domain are adducted to evaluate the described approach.

Adaptively Perturbing Localized State Space in Data Assimilation of Wildfire Spread Simulation

Feng Gu

Summary

Real time data can be assimilated into the simulation model using sequential Monte Carlo (SMC) methods to improve the estimation of the wildfire spread simulation. The standard SMC methods algorithm uses a fixed number of particles and doesn't have run-time state inference estimation and particle convergence characterization. Therefore, the convergence of particles cannot be guaranteed and a large number of particles are required to ensure that the state space is effectively covered by the particles and the particles can converge to the true posterior of the system state. For wildfire spread simulation, the system has a large spatial state and its system behaviors are heterogeneous in different areas. This type of heterogeneous and spatial-temporal dynamic behavior results in non-uniform and dynamic changing uncertainty of state inference. In this paper, we develop the algorithm to adaptively perturb the localized state space to achieve more effective coverage of the state space. The experimental results show that more accurate results are obtained by adaptively perturbing the localized state space for data assimilation of wildfire spread simulation.

Particle Filter Based Traffic Data Assimilation with Sensor Informed Proposal Distribution

Peisheng Wu, Haidong Xue and Xiaolin Hu

Summary

This paper presents particle filter with sensor informed proposal distribution for traffic state estimation. A microscopic agent based traffic simulator is employed to simulate the traffic network and vehicle behaviors. With sensor component plug in, the proposed framework estimate the density of the traffic network along with the location of traffic accidents. The presented sensor informed proposal distribution facilitates the observation data to construct the system state by combining local sensor proposal. The performance is validated and evaluated by means of identical twin experiments carried out on both Bootstrap and sensor informed proposal particle filter. The comparison result shows that the proposed data assimilation framework outperforms Bootstrap particle filter with respect to accuracy and efficiency.

Abstract

A Domain Ontology for Ballistic Missile Defense Conceptual Model

Wenguang Wang, Feng Yang, Weibing Ma, Xiaobo Li and Yangbo Wu

Summary

Ballistic missiles countermeasure against the missile defense system involves multiple typical armaments, various counter measures, and complex operation processes. The professionals and applications face the problem of acquisition and interoperation of various domain knowledge. Taking the ballistic missile defense as the application domain, we firstly identify the concepts of basic entities, processes, counter measures and their relationships. Then we propose a domain ontology for ballistic missile defense. The proposed domain ontology merges and interconnects the knowledge of the armaments, processes, and counter measures. Taking some typical examples, we finally show the application of the domain ontology in knowledge inference and model checking.

Accelerated Portfolio Optimization With Conditional Value-at-Risk Constraints Using A Cutting-Plane Method

Georg Hofmann

Summary

Financial portfolios are often optimized for maximum profit while subject to a constraint formulated in terms of the Conditional Value-at-Risk (CVaR). This amounts to solving a linear problem. However, in its original formulation this problem has a very large number of constraints, too many to be enforced in practice. In the literature this is addressed by a reformulation of the problem using so-called dummy variables. This reduces the large number of constraints in the original linear problem at the cost of increasing the number of variables. In the context of reinsurance portfolio optimization we observe that the increase in variable count can lead to situations where solving the reformulated problem takes a long time. Therefore we suggest a different approach. We solve the original linear problem with cutting-plane method: The proposed algorithm starts with the solution of a relaxed problem and then iteratively adds cuts until the solution is approximated within a preset threshold. The application of this method to financial portfolios is not documented in the literature at this point in time. For a reinsurance case study we show that a significant reduction of necessary computer resources can be achieved.

A Comparison of a Generic MCMC-based Algorithm for Bayesian Estimation in C++, R and Julia Application to Plant Growth Modeling.

Gautier Viaud, Yuting Chen, Benoit Bayol and Paul-Henry Cournede

Summary

Plant growth is understood through the use of dynamical systems involving many interacting processes and model parameters whose estimation is therefore a crucial issue, all the more so since experimental data obtained from agronomical systems are most of the time characterized by their scarcity and their heterogeneity owing to the complex underlying acquisition. One of the approaches used to solve this kind of problem within a Bayesian paradigm involves Markov Chain Monte Carlo (MCMC) algorithms, one of the drawbacks of the latter being that they lead to some intensive computation because of the statistical framework employed, which is why the efficiency of the implemented computing methods is of particular importance. In this paper, we compare three implementations of a generic MCMC-based algorithm for Bayesian estimation in C++, R and Julia so as to compare the performance and precision of these languages. Here, genericness means that the estimation algorithm can be used for any dynamic model provided that it is implemented in a given modeling template. Such genericness is of crucial importance in a scientific field such as plant growth modeling for which no reference model exists and new models are constantly developed and evaluated. The tests are conducted for the particular case of the Log-Normal Allocation and Senescence (LNAS) model for sugar beet.

Paradigms for Conceptual Modeling

Ricardo Roca, Dale Pace, Stewart Robinson, Andreas Tolk and Levent Yilmaz

Summary

The Department of Defense (DoD) Modeling & Simulation Coordination Office (M&SCO) in collaboration with the Personnel & Readiness (P&R)/Force Readiness & Training (FR&T) Directorate/Joint Assessment and Enabling Capability (JAEC) Office sponsored the initial work on a handbook on Conceptual Modeling. The objective of such a handbook is the presentation of various paradigms that can help the project managers and project execution offices (PEO) to support their various needs. This paper presents a subset of these paradigms covered in more detail in the handbook such as conceptual modeling for data rights management, the Robinson Template to capture conceptual modeling for management, conceptual modeling of information exchange, longevity and reuse, general methods contributing to recommended best practices of conceptual modeling, and intellectual property rights.

Abstract

Contiki Cooja Simulation for Time Bounded Localization In wireless Sensor Network

Mona Nasser, Hussein Al-Olimat, Robert Green, Mansoo Alam and Wei Cheng

Summary

An attractive research topic in wireless sensor networks is the issue of localization – that is localizing an entire wireless sensor network accurately and within a reasonable time frame. A newly developed algorithm in this area is Time Bounded Essential Localization (TBEL), which allows for rapid, network-wide distribution of essential location information with full localization to occur at a later time. In order to further develop this line of research, this study evaluates the implementation of a variant of TBEL (TBL) on the Cooja simulation platform as it enables not only the simulation of TBL, but the eventual implementation of this algorithm on real world nodes. The Simulation results show that in a limited four rounds of communication, 76.67% of nodes would be localized with an average localization error of 0.5 meters in a 200m by 200m simulation area including 30 blind nodes and 50 anchors.

Communication Security in the Internet of Things: Preventive Measure for Avoiding DDoS Attacks Over IoT Network

Congyingzi Zhang and Robert Green

Summary

The idea of Internet of Things (IoT) is implanting heterogeneous detectors connected with network into our daily life. It opens an extra channel for information submission and remote control to our physical world. The most significant difference between IoT and the well-known Internet is it collecting rather than distributing data to the network edges. Moreover, according to the design goal of the IoT, the amount of human interaction in the network is greatly lowered, which suggests the IoT network need to be highly self-managed and self-secured. For the reason that the use of IoT is growing in many important fields, the security issues of IoT need to be properly addressed. Among all, Distributed Denial of Service (DDoS) is one of the most notorious attacking behaviors over network which interrupts or blocks genuine user requests by flooding the host server with huge number of requests sent from a group of zombie computers via geographically distributed internet connections. DDoS disrupts service by creating network congestion and disabling normal functions of network components, which is even more disruptive for IoT. In this paper, a lightweight defensive algorithm for DDoS attack over IoT network environment is proposed and tested against several scenarios to dissect the interactive communication among different types of network nodes using the Contiki Cooja simulation tool.

Agent-based Simulation in Support of Moving Target Cyber Defense Technology Development and Evaluation

Benjamin Priest, Era Vuksani, Neal Wagner, Brady Tello, Kevin Carter and William Streilein

Summary

Moving target (MT) technologies are a class of cyber security defensive techniques that seek to protect computer networks by making them less homogenous, less static, and less deterministic in order to increase the complexity required for a successful cyber attack. MT techniques are associated with performance costs, and thus their effectiveness and overhead must be evaluated before deployment in a live setting. However, testing the effectiveness and usage costs of a newly-developed MT technique on a live computer network is a costly process. This paper presents an agent-based approach for simulating an operational network and measuring the impact of security policies that incorporate MT technologies. The proposed agent-based simulation system (ABS) is intended to evaluate candidate MT techniques and provide important and cost-effective support for the overall MT technology development and testing process. We demonstrate the ABS model via a case study that evaluates a particular MT technology and discuss how this evaluation via simulation can be used to support the larger process of MT technology development and testing.

A Fine-Grained Flow Control Model for Cloud-Assisted Data Broadcasting

Ning Yu, Feng Gu, Xuan Guo and Zaobo He

Summary

Cloud-assisted data broadcasting is an emerging application where cloud computing assists data broadcasting to extend the capacity of system computing and improve the interactivity of the conventional media. However, with the increase in scale, it brings the difficulty on the complexity to provide the sufficient quality of service for diverse receivers. In order to obtain a fine-grained flow rate as well as the system stability, we propose a model based on parallel scheduling, fair queue and Proportional-Integral-Derivative (PID) controller to cope with these challenges. PID controller takes advantage of the feedback of the statistical output stream and automatically adjusts the transmission flow so that the system can achieve the fine-grained multiplexing performance. Meanwhile, we adopt a set of novel metrics to monitor and measure the quality of flow control in order to weaken the negative impact of coarse-grained flow to user-end devices to the minimum level. Extensive simulations and evaluations have illustrated the superiority of the proposed model in the performance and the quality of service in terms of proposed measurement metrics.

Abstract

Dynamic Link Budget Simulation for High Altitude Balloon Data Link Experiment

James Taylor, Thaine Rowley, KayLee Taylor, Dakoda Kilzer, Cody Largent and Makenzie Petersen

Summary

With the growing interest in high altitude balloon experiments for Science, Technology, Engineering, and Math (STEM) outreach, the desire for more capable data links, to include 802.11-based solutions, has also increased. This paper addresses the challenges of modeling and simulating an 802.11-based data link throughout its flight on a high altitude research balloon. Of special interest in this simulation are modeling of the 3-dimensional nature of the antenna gain for both the transmitter and receiver throughout the flight trajectory of the balloon and modeling of the balloon-borne antenna due to wind gusts. Key research questions to be answered are link stability over time and overall data throughput of the system throughout the duration of the mission. Once developed, this simulation will allow investigations into dynamic protocol modifications, such as modifications to the transmission rate, which may provide an increase in overall data throughput. Results from this simulation will be used to generate specifications for a high altitude balloon data link experiment that will feature a live streaming video link to a ground station during an experimental mission.

Malware Detection Inspired by The Human Immune System and Making Use of Honeytokens

John Cossu and Hala ElAarag

Summary

Computers are constantly faced with the threat of attack. Hackers are frequently updating their methods of attacking to severely damage computers. Advancement in technology has inspired new theories to explain the human immune system. Research in human immunology has proved to be a great competitor of viruses. In this paper we propose a multistage malware detection algorithm inspired by the human immune system. The first stage of the algorithm utilizes the Danger Theory while in the second stage it utilizes the Negative Selection Theory. To study our proposed malware detection system, we use three important performance measurements, namely, execution time, false positives, and false negatives. Our simulation shows the effectiveness of our system that detected malware 100% of the time.

Automatic Validation for Multi Criteria Decision Making Models in Simulation Environments

Mubarak Alrashoud, Meshary AlMeshary and Abdolreza Abhari

Summary

This paper presents a technique for validating decision support modes frameworks that are tested using simulated data. In human-based decision making problems, the data is provided by the decision makers. The validity of the decision support models can be evaluated by calculating the degree of decision makers' satisfaction. The more degree of satisfaction, the more reliable and accurate the decision support model is. However, in most of cases, it is not possible for decision models implementers to find realistic data to validate their models. Therefore, they use simulated data. This paper proposes a technique to measure the satisfactions of simulated decision makers (agents). The experiments show that using this technique can provide the decision models implementers with more confidence about the results of the implemented decision support models.

Automatic Classification of the Emotional Content of URL Documents Using NLP Algorithms

Alaa Hussainalsaid, Bahram ZahirAzami and Abdolreza Abhari

Summary

In the recent decades, a huge amount of information is available in the form of URL documents, but not all contents that are posted there are positive or useful in providing the requested information. Therefore, the automatic detection of emotions in texts becomes increasingly important to deal with this task. Natural language processing can help to automatically classify the emotional content of URL documents. This paper discusses a Sentiment Analyzer that extracts sentiment of website text documents. Sentiment Analyzer detects URL documents and labels them as either positive or negative, and determines sentiment in each of the URL documents using natural language processing (NLP) techniques. In this paper we propose using bi-gram that is known as a special type of N-gram, (where $N=2$). Bi-gram looks into couples of two consecutive words in a document. The performance of the algorithm will be verified on online articles and general documents, such as general web pages and news articles.

DEVS Based Modeling of Shared Segmented Upload in LTE-A Mobile Networks

Misagh Tavanpour

Summary

In recent years, there have been important efforts focusing on providing suitable services for mobile networks users and on supporting their increasing demands. One promising standard is called Long Term Evolution Advanced (LTE-A). LTE-A uses different techniques (such as Coordinated Multipoint - CoMP) to deal with bottlenecks to improve performance, in particular for users at the edge of the cells. Here, we show a simulation study focused on the Shared Segmented Upload (SSU) algorithm, which deals with these problems. We use the Discrete Event System Specification (DEVS) formalism to model two different approaches. The simulations show how the SSU algorithm improves services for cell edge users. We show how to define these kinds of applications using a formal framework like DEVS.

18th Communications and Networking Symposium (CNS)

Abstract

Follow the Pheromone Trail – on Studying Ant Routing Algorithms in Simulation and Wireless Testbeds

Michael Frey

Summary

The Internet of Things (IoT) proposes the interconnection of millions of physical and virtual objects enabling us to interact with our environment in smarter ways. While there are multiple interpretations of the IoT, typically all visions share one commonality - the communication is going to be mostly wireless. Providing adaptive and scalable wireless networks for the IoT is one of the most challenging tasks. Researchers propose the application of bio-inspired networking algorithms in order to tackle these issues. However, studying these algorithms for the IoT opposes its own set of problems and challenges. We present a methodology and a framework to study a particular class of bio-inspired algorithms. The framework enables researchers to study and compare them on the algorithmic level and an approach to run large simulation studies in a comprehensive way.

Comparison of Data Analysis Tools for Trending Thermal Comfort Parameters

Abdolreza Abhari and Lubaid Ahmed

Summary

This paper uses regression analysis to examine its efficiency for data analysis in thermal comfort parameters datasets in comparison with Artificial Neural Networks (ANN). Several regression models are designed by analyzing the thermal comfort datasets which are collected by sensor networks for temperature, humidity and air flow in a residential building. The datasets of thermal comfort parameters were collected by wireless sensor networks which are installed in 4th floor of an educational building. In this research the effects of building structure parameters (utilized by the regression and ANN models) together with the time of a day is examined on thermal comfort parameter of temperature and air flow.

SALIENT: Stochastic, Adaptive Latency Improvement for Event Notification Trees

Jason Long and Jeremy Blum

Summary

A challenge in massively multiplayer online games is the need for game event information to be quickly disseminated to all participants. Because of the cost and scalability limitations of centralized servers, peer-to-peer technologies have been adopted in which peers serve both to reconcile conflicting actions and to relay the events to other peers. This manuscript introduces Stochastic, Adaptive Latency Improvement for Event Notification Trees (SALIENT), which provides a method for constructing and maintaining a peer-to-peer event notification tree. SALIENT is a distributed algorithm that uses a number of independent mechanisms that work over time to incrementally make improvements to the event notification tree. In random networks of various sizes, SALIENT was found to greatly reduce experienced latency, typically as much as 40-60% reduction in event delays. In addition, SALIENT has bandwidth management strategies that help avoid situations of bandwidth overload, allowing many more participants to participate despite limited participant bandwidth.

23rd High Performance Computing Symposia (HPC)

Abstract

Towards a More Fault Resilient Multigrid Solver

Jon Calhoun, Luke Olson, Marc Snir and William Gropp

Summary

The effectiveness of sparse, linear solvers is typically studied in terms of their convergence properties and computational complexity, while their ability to handle transient hardware errors, such as bit-flips that lead to silent data corruptions (SDCs), has received less attention. As supercomputers continue to add more cores to increase performance, they are also becoming more susceptible to SDCs. Consequently, understanding the impact of SDCs on algorithms and common applications is an important component of solver analysis. In this paper, we investigate algebraic multigrid (AMG) in an environment exposed to corruptions through bit-flips. We propose an algorithmic based detection and recovery scheme that maintains the numerical properties of AMG, while maintaining high convergence rates in this environment. We also introduce a performance model and numerical results in support of the methodology.

Exploiting Computing Power of Xeon and Intel Xeon Phi for a Molecular Dynamics Application

Benny Mathew, Nitin Rai, Apaar Gupta and Amit Harode

Summary

Molecular Dynamics (MD) is a computational technique with applicability in fields as diverse as material science, biomolecules and chemical physics. Assisted Model Building with Energy Refinement (AMBER) is an MD package and it uses Message Passing Interface (MPI) to scale in multi-core and cluster environments. In our earlier work, we modified one of AMBER's algorithms called Generalized Born (GB) algorithm to run optimally on the Xeon Phi co-processor. This improved performance by 277% on the co-processor. The same changes improved performance on the host server by 80%. In this paper, we extend our earlier work and implement a symmetric solution using both the host server and the co-processor. Since the calculations in GB algorithm involve interactions between all possible atom combinations, it has been very difficult to scale GB algorithm in distributed memory. We evaluate various alternate techniques using combination of MPI and Open Multi-Processing (OpenMP) to get a scalable solution that utilizes the computing power of both the host server as well as the co-processor.

Fast Parallel Conversion of Edge List to Adjacency List for Large-scale Graphs

Shaikh Arifuzzaman and Maleq Khan

Summary

In the era of bigdata, we are deluged with massive graph data emerged from numerous social and scientific applications. In most cases, graph data are generated as lists of edges (text{edge list}), where an edge denotes a link between a pair of entities. However, most of the graph algorithms work efficiently when information of the adjacent nodes (text{adjacency list}) for each node are readily available. Although the conversion from edge list to adjacency list can be trivially done on the fly for small graphs, such conversion becomes challenging for the emerging large-scale graphs consisting billions of nodes and edges. These graphs do not fit into the main memory of a single computing machine and thus require distributed-memory parallel or external-memory algorithms. In this paper, we present efficient MPI-based distributed memory parallel algorithms for converting edge lists to adjacency lists. To the best of our knowledge, this is the first work on this problem. To address the critical load balancing issue, we present a parallel load balancing scheme which improves both time and space efficiency significantly. Our fast parallel algorithm works on massive graphs, achieves very good speedups, and scales to large number of processors. The algorithm can convert an edge list of a graph with 20 billion edges to the adjacency list in less than 2 minutes using 1024 processors. Denoting the number of nodes, edges and processors by n , m , and P , respectively, the time complexity of our algorithm is $O(m/P + n + P)$ which provides a speedup factor of at least $\Omega(\min\{P, d_{avg}\})$, where d_{avg} is the average degree of the nodes. The algorithm has a space complexity of $O(m/P)$, which is optimal.

A Research Framework for Exascale Simulations of Distributed Virtual World Environments on High Performance Computing (HPC) Clusters

Amit Goel, William Rivera, Peter Kincaid and Neal Finkstein

Summary

Distributed Virtual Environment Simulators such as OpenSimulator and SecondLife have become very popular in the simulation field over the last decade. However, these simulators pose a greater challenge with increased load due to High-Fidelity of simulations, higher number of objects and agents and increased levels of interactions. In this paper we propose a framework for Distributed Virtual World Environment Simulators Research on High Performance Computing (HPC) Clusters. Our proposed framework is very useful for Virtual World Researchers as HPC clusters are available more freely as compared to setting up their own cluster dedicated to Virtual Environment Simulation. Although we implemented and validated our framework on Stokes Cluster at UCF Advanced Research Computing Center and OpenSimulator Virtual World; our proposed framework is generic enough to be extended to other HPC Clusters and Distributed Virtual Environments.

Abstract

Fast Sparse Matrix Multiplication on GPU

Lukas Polok, Viorela Ila and Pavel Smrz

Summary

Sparse matrix multiplication is an important algorithm in a wide variety of problems, including graph algorithms, simulations and linear solving to name a few. Yet, there are but a few works related to acceleration of sparse matrix multiplication on a GPU. We present a fast, novel algorithm for sparse matrix multiplication, outperforming the previous algorithm on GPU up to 3x and CPU up to 30x. The principal improvements include more efficient load balancing strategy, and a faster sorting algorithm. The main contribution is design and implementation of efficient sparse matrix multiplication algorithm and extending it to sparse block matrices, which is to our best knowledge the first implementation of this kind.

ExaShark: A Scalable Hybrid Array Kit for Exascale Simulation

Imen Chakroun, Tom Vander Aa, Bruno De Fraine, Tom Haber, Roel Wuyts and Wolfgang Demeuter

Summary

Many problems in high-performance computing, such as stencil applications in iterative solvers or in particle-based simulations, have a need for regular distributed grids. Libraries offering such n-dimensional regular grids need to take advantage of the latest high-performance computing technologies and scale to exascale systems, but also need to be usable by non HPC experts. This paper presents ExaShark: a library for handling n-dimensional distributed data structures that strikes a balance between performance and usability. ExaShark is an open source middleware, offered as a library, targeted at reducing the increasing programming burden on heterogeneous current and future exascale architectures. It offers its users a global-array-like usability while its runtime can be configured to use shared memory threading techniques (Pthreads, OpenMP, TBB), inter-node distribution techniques (MPI, GPI), or combinations of both. ExaShark has been used to develop applications such as a Jacobian 2D heat simulation and advanced pipelined conjugate gradient solvers. These applications are used to demonstrate the performance and usability of ExaShark.

A Load Balancing Parallel Method for Frequent Pattern Mining on Multi-core Cluster

Lan Vu and Gita Alagband

Summary

In this paper, we present a new parallel method named SDFEM that enables frequent pattern mining (FPM) on cluster with multiple multi-core compute nodes to provide high performance. SDFEM is distinguished from previous parallel FPM works due to incorporating three advanced features to provide high mining performance for large-scale data analytic applications. First, SDFEM combines both shared memory and distributed memory computational models to leverage benefits of shared memory within a node in cluster. Second, it employs a multi-strategy load balancing approach to address the most challenging issue of parallel FPM to balance the mining workload among all cores of the cluster. Finally, its self-adaptive mining solution with the capability of dynamically adjusting to the characteristics of the database to perform efficiently on different data types either sparse or dense. For performance evaluation, we implement SDFEM using a hybrid model of OpenMP and MPI in which OpenMP is for the shared memory model and MPI is for message passing. SDFEM has been tested on a cluster of multiple 12-core shared memory compute nodes. Our experimental results on real databases show that performance of SDFEM is up to 329.5% faster than the parallel FPM approach that uses only distributed memory model with message passing (i.e. using pure MPI). In addition, SDFEM can achieve up to 45.4 – 64.8 speedup on 120 cores (i.e. 10 compute nodes and 12 cores per node).

Efficient Scaling of a Hydrodynamics Simulation Using Compiler-based Accelerator Technology

Jordan Bradshaw, Behzad Torkian and Philip Moore

Summary

Efficient Scaling of a Hydrodynamics Simulation Using Compiler-based Accelerator Technology. In the realm of numerical simulations, there is often a requirement to run simulations with higher spatial and temporal resolutions. Although increasing resolution can improve the accuracy of simulations, there is always a corresponding increase in the run time. These run times can become impractical for conventional sequentially coded simulations. Parallelizing simulation code can open great possibilities for improved run-time performance, but it can be very difficult to achieve the necessary speedups when software development and debugging time are considered. This is especially the case when extensive modifications to legacy source code are needed to incorporate parallel processing capabilities. More complications can arise when subtle discrepancies in the simulation results are observed after parallelization. To address this problem, we used The Portland Group's compiler to parallelize ALGE3D, a DOE developed hydrodynamics simulation, using OpenACC inspired directives to target Nvidia GPU hardware. This compiler-level parallel development environment enabled us to modify an existing legacy program with minimal alterations to the original source code. The rapid development permitted by this compiler was instrumental in the process of overcoming challenges in parallelization, such as identifying performance bottlenecks, race conditions and incorrect code translation. Using this compiler and a rigorous testing methodology, we were able to achieve more than a 30x speedup using a single Nvidia Tesla GPU and reduce the run time of high-resolution simulations from months to days while verifying that results were equivalent to the sequential legacy version of the simulation.

Abstract

Sharer Status-based Caching in Tiled Multiprocessor Systems-on-Chip

Preethi Parayil Mana Damodaran, Aurang Zaib, Thomas Wild, Stefan Wallentowitz and Andreas Herkersdorf

Summary

In multi-core systems with cache-to-cache forwarding, the data access latency depends heavily on the sharer status of cache-lines (CLs). The sharer status of a CL is defined by the number of copies of the CL in the whole system. Exclusive single-copy CLs have higher latency for different cache operations (e.g. misses, eviction, invalidation) when compared to shared multi-copy CLs. This is because, single-copy CL misses have to target globally shared system memory in case of a miss, while multi-copy misses may retrieve data from a CL in the neighborhood. These differences lead to dissimilarity in cache design requirements for single-copy CLs and multi-copy CLs. Unfortunately, state-of-the-art private cache designs do not consider this dissimilarity of CLs in all aspects of the cache design. This results in overhead in data access time and cache usage. In this paper, we present a concept of dynamic partitioning of the CLs depending on their sharer status (either single-copy or multi-copy). Based on this concept, we introduce a cache hierarchy in which the hierarchy levels are made different depending on the sharer status of CLs and vary dynamically according to application requirements. In addition, we propose an optimized coherence scheme that reduces the latency overhead of single-copy CLs. The scheme also provides an automatic write-upgrade which reduces the write access time. A cycle-accurate SystemC model of the proposed caching concept is simulated using SPLASH-2 and PARSEC benchmarks. It shows a more than 10% reduction in average memory access time compared to locality-aware adaptive cache models. It also shows a more than 40% reduction in average memory access time compared to cooperative cache models such as elastic and distributed cooperative caches where, these access latency benefits come at a cost of an on average 30% increase in network-on-chip (NoC) traffic. This once more underpins that an appropriately dimensioned on-chip interconnect is prerequisite for attaining high compute performance in large multi-core systems.

Accelerating the LOBPCG Method on GPUs Using a Blocked Sparse Matrix Vector Product

Hartwig Anzt, Stanimire Tomov and Jack Dongarra

Summary

This paper presents a heterogeneous CPU-GPU implementation for a sparse iterative eigensolver - the Locally Optimal Block Preconditioned Conjugate Gradient (LOBPCG). For the key routine generating the Krylov search spaces via the product of a sparse matrix and a block of vectors, we propose a GPU kernel based on a modified sliced ELLPACK format. Blocking a set of vectors and processing them simultaneously accelerates the computation of a set of consecutive SpMV's significantly. Comparing the performance against similar routines from Intel's MKL and NVIDIA's cuSPARSE library we identify appealing performance improvements. We integrate it into the highly optimized LOBPCG implementation. Compared to the BLOBEX CPU implementation running on two eight-core Intel Xeon E5-2690s, we accelerate the computation of a small set of eigenvectors using NVIDIA's K40 GPU by typically more than an order of magnitude.

Incremental, Distributed Single-Linkage Hierarchical Clustering Algorithm Using MapReduce

Chen Jin, William Hendrix, Zhengzhang Chen, Ankit Agrawal and Alok Choudhary

Summary

Single-linkage hierarchical clustering is one of the prominent and widely-used data mining techniques for its informative representation of clustering results. However, the parallelization of this algorithm is challenging as it exhibits inherent data dependency during the hierarchical tree construction. Moreover, in many modern applications, new data is continuously added into the already huge datasets. It would be impractical to reapply the clustering algorithm on the augmented datasets from scratch. In this paper, we propose a unified algorithm which can not only cluster the large dataset, but also incorporate the newly arrived data incrementally. More specifically, we formulate the single-linkage hierarchical clustering problem as a Minimum Spanning Tree (MST) construction problem on a complete graph. The algorithm decomposes the complete graph into a set of non-overlapped subgraphs, computes the intermediate sub-MSTs for each subgraph in parallel, and merges all the sub-MSTs to achieve the final solution. In addition, the same framework can treat the incremental data insertion as a separate data subset and integrate it nicely with the existing solution. We implement the unified algorithm by employing MapReduce framework. Using both synthetic and real-world datasets containing up to millions of high-dimensional points, we show that the proposed algorithm achieves a scalable speedup up to 200 on 300 computer cores for the base dataset and a speedup up to 120 for the dataset with maximum 5% random insertion.

Throughput Studies on an InfiniBand Interconnect via All-to-All Communications

Nil Mistry, Jordan Ramsey, Benjamin Wiley, Jackie Yanchuck, Xuan Huang and Matthias Gobbert

Summary

Distributed-memory clusters are the most important type of parallel computer today, and they dominate the TOP500 list. The InfiniBand interconnect is the most popular network for distributed-memory compute clusters. Contention of communications across a switched network that connects multiple compute nodes in a distributed-memory cluster may seriously degrade performance of parallel code. This contention is maximized when communicating large blocks of data among all parallel processes simultaneously. This communication pattern arises in many important algorithms such as parallel sorting. The cluster tatra in the UMBC High Performance Computing Facility (HPCF) with a quad-data rate InfiniBand interconnect provides an opportunity to test if the capacity of a switched network can become a limiting factor in algorithmic performance. We find that we can design a test case of a problem involving increasing usage of memory that does not scale any more on the InfiniBand interconnect, thus becoming a limiting factor for parallel scalability. However, for the case of stable memory usage of the problem, the InfiniBand communications get faster and will not inhibit parallel scalability. The tests in this paper are designed to involve only basic MPI commands for wide reproducibility, and the paper provides the detailed motivation of the design of the memory usage needed for the tests.

Parallel Performance of Higher-Order Methods on GPU Hardware

Tyler Spilhaus, Jared Buckley and Gaurav Khanna

Summary

There is considerable current interest in higher-order methods and also large-scale parallel computing in nearly all areas of science and engineering. In this work, we take a number of basic finite-difference stencils that compute a numerical derivative to different orders of accuracy and carefully study the overall performance of each, on a many-core processor i.e. a graphics processing unit (GPU). We conclude that if one has a code that exhibits a high order of convergence, then there is likely to be only a modest gain through GPU parallelism in the context of total execution or "wall-clock" time. Conversely, for a low order code that exhibits good parallel performance, there is insignificant gain through the implementation of a higher-order convergent algorithm.

DOEE: Dynamic Optimization framework for Better Energy Efficiency

Jawad Haj-Yihia, Ahmad Yasin and Yosi Ben-Asher

Summary

The growing adoption of mobile devices powered by batteries along with the high power costs in datacenters raise the need for energy efficient computing. Dynamic Voltage and Frequency Scaling is often used by the operating system to balance power-performance. However, optimizing for energy-efficiency faces multiple challenges such as when dealing with non-steady state workloads. In this work we develop DOEE - a novel method that optimizes certain processor features for energy efficiency using user-supplied metrics. The optimization is dynamic, taking into account the runtime characteristics of the workload and the platform. The method instruments monitoring code to search for per-program-phase optimal feature-configurations that ultimately improve system energy efficiency. We demonstrate the framework using the LLVM compiler when tuning the Turbo Boost feature on modern Intel Core processors. Our implementation improves energy efficiency by up to 23% on SPEC CPU2006 benchmarks, outperforming the energy-efficient firmware algorithm. This framework paves the way for auto-tuning additional CPU features.

Predicting Energy Consumption Relevant Indicators of Strong Scaling HPC Applications for Different Compute Resource Configurations

Hayk Shoukourian, Torsten Wilde, Axel Auweter, Arndt Bode and Daniele Tafani

Summary

Finding the best energy-performance tradeoffs for High Performance Computing (HPC) applications is a major challenge for many modern supercomputing centers. With the increased focus on data center energy efficiency and the emergence of possible data center power constraints, making the right decision at a given time is becoming more important. A real-world situation like "Can a given 1000 compute node application be executed without going over the energy provider defined power band, or the available monthly energy limit?" is just one example of the types of decisions HPC data centers will face. This paper will extend the previously developed Adaptive Energy and Power Consumption Prediction process to enable the development of analytical models for estimating application execution time, power, and energy consumptions as functions of the number of compute nodes and CPU frequency. Based on these analytical models, an adaptive model (Lightweight Adaptive Consumption Prediction (LACP)) is presented that implements the extended prediction process. This information allows for improved estimation of potential energy-performance costs and tradeoffs of applications and thus identifies the optimal resource configuration for specific data center boundary conditions.

Abstract

A Virtual Machine Model for Accelerating Relational Database Joins using a General Purpose GPU

Kevin Angstadt and Ed Harcourt

Summary

We demonstrate a speedup for database joins using a general purpose graphics processing unit (GPGPU). The technique is novel in that it operates on an SQL virtual machine model developed using CUDA. The implementation compiles an SQL statement to instructions of the virtual machine that are then executed in parallel on the GPU. We use the three-dimensional structure of the CUDA grid and thread model to perform a join on up to three relations at a time. Query execution results in speedups of 2 to 60 times on consumer-level GPUs depending on the size of the result set.

Performance Analysis and Design of a Hessenberg Reduction using Stabilized Blocked Elementary Transformations for New Architectures

Khairul Kabir, Azzam Haidar, Stan Tomov and Jack Dongarra

Summary

The solution of nonsymmetric eigenvalue problems, $Ax = \lambda x$, can be accelerated substantially by first reducing A to an upper Hessenberg matrix H that has the same eigenvalues as A . This can be done using Householder orthogonal transformations, which is a well established standard, or stabilized elementary transformations. The latter approach, although having half the flops of the former, has been used less in practice, e.g., on computer architectures with well developed hierarchical memories, because of its memory-bound operations and the complexity in stabilizing it. In this paper we revisit the stabilized elementary transformations approach in the context of new architectures -- both multicore CPUs and Xeon Phi coprocessors. We derive for a first time a blocking version of the algorithm. The blocked version reduces the memory-bound operations and we analyze its performance. A performance model is developed that shows the limitations of both approaches. The competitiveness of using stabilized elementary transformations has been quantified, highlighting that it can be 20% to 30% faster on current high-end multicore CPUs and Xeon Phi coprocessors.

Efficient Algorithms for Improving the Performance of Read Operations in Distributed File System

Lakshmi Siva Rama Krishna Talluri, Ragunathan Thirumalaisamy and Sudheer Kumar Battula

Summary

Distributed file systems (DFSs) are used in the modern cloud-based systems to store and process a large amount of data. File sharing semantics is used by the DFS for sharing the data in a consistent manner among the authorized users of the system. The limitation of popular session semantics is that read client processes cannot read the modifications done by a concurrent write client process on the same shared file in the same session. Linearizability semantics followed in the BlobSeer DFS permits the read client processes to read the previous version of a binary large object (blob) while concurrent write operation is carried out on that blob. In this paper, we have proposed a new type of semantics namely "Speculative Semantics" and new metric namely "Currency". Speculative semantics permits the read client processes to read the modifications done by the concurrent write client process in the same session. Currency is the metric used for measuring the performance of the read algorithms. In this paper, we have proposed two new read algorithms based on speculative semantics. We have conducted experiments on Blobseer DFS to measure the performance of these read algorithms and the results obtained indicate that the proposed algorithms perform better than existing read algorithm of the BlobSeer DFS.

Long-time Simulation of Calcium Induced Calcium Release In A Heart Cell Using Finite Element Method on a Hybrid CPU/GPU Node

Xuan Huang and Matthias Gobbert

Summary

A mathematical model of Calcium Induced Calcium Release in a heart cell has been developed that consists of three coupled non-linear advection-diffusion-reaction equations. A program in C with MPI based on matrix-free Newton-Krylov method gives very good scalability, but still requires large run times for fine meshes. A programming model with CUDA and MPI that utilizes GPUs on multiple nodes can significantly reduce the wall clock time. This paper reports initial results that demonstrate speedup using a hybrid node with two CPUs and two GPUs over the best results on a CPU node.

23rd High Performance Computing Symposia (HPC)

Abstract

High Performance Kirchhoff Pre-Stack Depth Migration on Hadoop

Chao Li, Yida Wang, Haihua Yan, Changhai Zhao and Jianlei Zhang

Summary

Kirchhoff Pre-Stack Depth Migration (KPSDM), a widely used seismic imaging algorithm in petroleum industry, is a typical IO-bound application since a large amount of seismic data and travel timetable data needs to be read from the storage system iteratively during runtime. We present an optimized high performance KPSDM implementation called HKPSDM based on Hadoop where a large I/O aggregated bandwidth is offered cheaply to replace our previous implementation based on Network Attached Storage (NAS) appliances over NFS which have a limited I/O bandwidth when hundreds of processes participate in a migration job. In our implementation, MapReduce facilitates the travel timetable rearrangement and HDFS provides a stable and scalable storage system for seismic data as well as travel timetable data. Various optimizations are applied to HKPSDM to reduce the global bandwidth consumption of HDFS and overhead caused by some disadvantages of HDFS. Experimental results show that HKPSDM can scale better when the number of computing cores ranges from 160 to 800. HKPSDM performs more than 5 times better than NAS-based one when rearranging the travel timetables. And a 37% efficiency improvement is observed when 800 cores are used for migration.

Parallel QR Algorithm for the C-method: Application to the Diffraction by Gratings and Rough surfaces

Cihui Pan, Nahid Emad and Richard Dusséaux

Summary

The curvilinear coordinate method (C-method) is an exact method for analysing of electromagnetic waves scattering from rough surfaces. It is based on Maxwell's equations under covariant form written in a non-orthogonal coordinate system. This method leads to an eigenvalue system. All the eigenvalues and eigenvectors of the scattering matrix are required. The QR algorithm seems to be a suitable solution for this high dimension, dense, non-symmetric and complex scattering matrix. In this paper, we present the parallel QR algorithm that is specifically designed for the C-method. We defined the "early shift" for the scattering matrix according to the property that we have observed. We mixed the "early shift", Wilkinson's shift and exceptional shift together to accelerate the convergence. Especially, we use the "early shift" first to have quick deflation of the real eigenvalues of the scattering matrix. The multi-window bulge chain chasing and parallel aggressive early deflation are used. The multi-window bulge chain chasing approach ensures that most computations are performed in 3 BLAS operations. The aggressive early deflation approach can detect deflation much quicker and thus accelerate convergence. Mixed MPI-OpenMP techniques are utilized for performing the codes to distributed memory platforms. Numerical experiments are performed and applications of this parallel QR algorithm are applied to a real physical problem of diffraction.

A Study of Manycore Shared Memory Architecture as a Way to Build SOC Applications

Yosi Ben Asher, Yousef Shajrawi, Yacov Gendel, Gadi Haber and Oren Segal

Summary

Manycore shared memory architectures hold a significant premise to speed up and simplify SOC's. Using many homogeneous small-cores will allow replacing the hardware accelerators of SOC's by parallel algorithms communicating through shared memory. Currently shared memory is realized by maintaining cache-consistency across the cores, caching all the connected cores to one main memory module. This approach, though used today, is not likely to be scalable enough to support the high number of cores needed for highly parallel SOC's. Therefore we consider a theoretical scheme for shared memory wherein: the shared address space is divided between a set of memory modules; and a communication network allows each core to access every such module in parallel. Load-balancing between the memory modules is obtained by rehashing the memory address-space. We consider practical aspects involved with a practical realization of this scheme, e.g., how will the wire complexity of the communication network affect the execution time. We have designed a simple generic shared memory architecture, synthesized it to \$2,4,8,16, \dots, 1024\$-cores for FPGA virtex-7 and evaluated it on several parallel programs. The synthesis results and the execution measurements show that, for the FPGA, all problematic aspects of this construction can be resolved. For example, unlike ASICs, the growing complexity of the communication network is absorbed by the FPGA's routing grid and by its routing mechanism. This makes this type of architectures particularly suitable for FPGAs. We used 32-bits modified PACOBLAZE cores and tested different parameters of this architecture verifying its ability to achieve high speedups. The results suggest that re-hashing is not essential and one hash-function suffice (compared to the family of universal hash functions that is needed by the theoretical construction).

23rd High Performance Computing Symposia (HPC)

Abstract

Solving the Klein-Gordon Equation Using Fourier Spectral Methods: A Benchmark Test for Computer Performance

Samar Aseeri, Oleg Batrashev, Matteo Icardi, Brian Leu, Ning Ning, Albert Liu, Benson Muite, Eike Mueller, Michael Quell, Harald Servat, Parth Sheth, Robert Speck, Mark Van Moer and Jerome Vienne

Summary

The cubic Klein-Gordon equation is a simple but non-trivial partial differential equation whose numerical solution has the main building blocks required for the solution of many other partial differential equations. In this study, the library 2DECOMP&FFT is used in a Fourier spectral scheme to solve the Klein-Gordon equation and strong scaling of the code is examined on thirteen different machines for a problem size of 512^3 . The results are useful in assessing likely performance of other parallel fast Fourier transform based programs for solving partial differential equations. The problem is chosen to be large enough to solve on a workstation, yet also of interest to solve quickly on a supercomputer, in particular for parametric studies. Unlike other high performance computing benchmarks, for this problem size, the time to solution will not be improved by simply building a bigger supercomputer.

A Self-Adaptive Method for Frequent Pattern Mining using a CPU-GPU Hybrid Model **Lan Vu and Gita Alaghband**

Summary

Frequent pattern mining (FPM) is an important and computationally intensive task in data mining. We present a novel method, CGMM (CPU & GPU based Multi-strategy Mining), for mining frequent patterns that combines the computing power of CPU and GPU to speed up the frequent pattern mining. CGMM employs two different mining strategies and dynamically switches between them; the CPU-based strategy uses FP-tree data structure to perform the mining task on CPU while the GPU-based method converts the allocated data portions to bit vectors to work mainly on GPU. This unique approach has the following advantages compared to the existing methods: (1) utilizes the parallel processing capability of GPU for computationally intensive portions; the flexibility and low memory latency of CPU for the sophisticated data processing needed to manipulate the more complex data structures to enhance the overall performance (2) applies two mining strategies to efficiently mine both sparse and dense databases. The performance evaluation of CGMM on a machine with AMD CPUs and NVIDIA Tesla GPUs shows that in the best cases, the proposed method runs up to 229 times faster than well-known sequential FPM algorithms and 7.2 - 13.9 times faster than GApriori, a GPU based algorithm for FPM. In addition to outperforming them, CGMM has more stable performance on both dense and sparse test datasets.

Computational Steering for High Performance Computing Applications on Blue Gene/Q System

Bob Danani and Bruce D'Amora

Summary

The traditional workflow in a high performance computing (HPC) simulation is to prepare the application's input, run the simulation, and visualize the simulation results in a post-processing step. By performing these steps simultaneously, significant development and testing time can be saved. Computational steering provides the capability to direct or re-direct the progress of an HPC application at run-time by modifying application-defined control parameters using a steering client application. In this paper, we discuss a computational steering framework for the Blue Gene/Q system that provides an innovative solution and an easy-to-use platform, which allows user(s) to connect to and interact with running application(s) in real-time from native desktop steering applications and/or mobile devices. This framework uses RealityGrid as the underlying steering library and adds several enhancements to the library to enable steering support for the Blue Gene systems. The Blue Gene supercomputer presents special challenges for remote access because the compute nodes reside on private networks. This paper discusses an implemented solution for remote steering of simulation applications running on a high performance computer system and describes the implementation challenges.

Abstract

Strategies to Hide Communication for a Classical Molecular Dynamics Proxy Application

Issakar Ngatang and Masha Sosonkina

Summary

Co-designing applications and computer architectures has become of major importance due to the growing complexity of both applications and architectures and the need to better match application characteristics to the available hardware. Thus, “mini-applications”, which serve as proxies of large-scale ones by highlighting their most intensive parts and major workflow components, have appeared to the co-design, tuning, and adaptation purposes. This paper presents a work on optimizing the communication subsystem of a classical MD proxy (CoMD) application executed on multi-core computing clusters. The research focuses on hiding communication with certain buffer handling operations. In particular, two strategies are presented: one that uses two parallel threads for communication and buffer handling and another that introduces more parallelism by allowing all the available threads to unload the buffers while using two thread to communicate, thereby improving load balancing. The first proposed strategy yields performance gains up to 61% in the communication routines, corresponding to 6% gains in the overall time, while the second strategy achieves, respectively, about 73% and 6.3% improvement.

Shared-Memory Parallelization of the Semi-Ordered Fast Iterative Method

Josef Weinbub, Florian Dang, Tor Gillberg and Siegfried Selberherr

Summary

The semi-ordered fast iterative method allows to compute monotone front propagation of anisotropic nature by solving the eikonal equation. Compared to established iterative methods, such as the fast iterative method, the semi-ordered fast iterative method offers increased stability for variations in the front velocity. So far, the method has only been investigated in a serial, two-dimensional context; therefore, we investigate in this work a parallelization approach via OpenMP and evaluate it for three-dimensional problems, being especially of interest to real-world applications. We discuss the parallel algorithm and compare the performance as well as the computed solutions with an OpenMP-powered fast iterative method. We use different speed functions as well as varying problem sizes to investigate the impact of the computational load. We show that although the semi-ordered fast iterative method is inferior to the fast iterative method with respect to parallel efficiency, execution performance is significantly faster.

PerDome: A Performance Model for Heterogeneous Computing Systems

Li Tang, Xiaobo Sharon Hu and Richard F. Barrett

Summary

Heterogeneous systems, consisting of different types of processors, have the potential to offer higher performance at lower energy cost than homogeneous systems. However, it is rather challenging to actually achieve the high execution efficiency promised by such a system due to the larger design space and the lack of reliable performance/energy models for aiding design space exploration. This paper fills this gap by proposing a performance model for heterogeneous systems. In processor level, the roofline model can produce the performance upper bound of executed code using its ratio of computation to memory traffic. Our model, referred to as PerDome, builds on the roofline model and can reliably predict the system performance for both homogeneous execution (where each processor either executes the entire application code or none) and heterogeneous execution (where each processor executes part of the application code). Two case studies are carried out to demonstrate the effectiveness of PerDome. The results show that PerDome can indeed provide a good estimate for performance comparisons which can then be used for heterogeneous system design space exploration.

An Improved Probability-One Homotopy Map for Tracking Constrained Clustering Solutions

David Easterling, Layne Watson and Naren Ramakrishnan

Summary

This paper proposes a new homotopy map for use with constrained clustering problems, improving over previously introduced maps through the introduction of a K-Means approximation and the use of the Kreisselmeier-Steinhauser function to provide more efficient computation, as well as demonstrating through experimentation the power of this new map.

Productive Parallel Programming with Charm++

Phil Miller

Summary

Charm++ is a general purpose parallel programming framework for high-performance computing applications. It provides high productivity for developers through separation of concerns. Application programmers are responsible for providing scalable parallel algorithms that solve their problem of interest. The Charm++ runtime system is responsible for ensuring that the implementation of those algorithms executes efficiently across a wide range of platforms, and in the face of dynamic variation in work load and computational resources. This level of capability has allowed several Charm++ applications to run at full-machine scale on some of the largest supercomputers in the world.

Mobile Application

Abstract

3D Interactive Massage App

Yuzhong Yu, Shuo Ren and Zelin Zhu

Summary

Massage therapy is very effective for curing certain types of illnesses and is extremely safe and relaxing when performed correctly. The purpose of this mobile app is twofold. The first goal is to create an easy and interactive way for users to study and look up information about massage spots. The second goal is to provide users a simple do-it-yourself guide to massage therapy for specific illnesses.

DEVSImPy-Mob : Management of Ubiquitous Systems with a Mobile Application Using Discrete Event Simulations.

Timothée Ville, Souhila Sehili, Laurent Capocchi and Jean-François Santucci

Summary

The presentation deals with a mobile application called DEVSImPy-mob aimed to manage discrete event simulations obtained from DEVS (Discrete Event system Specification) models associated with connected objects such as board computers, sensors, controllers or actuators. The interest of such a proposition is to strongly associate Simulations, Mobile Apps and connected objects. The result will be the ability to manage connected objects (sensors, computer boards, actuators, controller) from a mobile application while providing intelligent decisions based on simulations. The user of the proposed the mobile application DEVSImPy-Mob will first have to connect to a board computer through the cloud. This connection will offer the user a list of DEVS models that can be simulated. These models are based on the DEVS formalism (Discrete Event system Specification) and involved a set of DEVS models in order to manage sensors, actuators, board computers or controller. One of the main interests of such an approach is the possibility to associated DEVS models of connected objects with classical DEVS models (such as prediction models, decision models, etc.) allowing to propose the management of connected objects from a mobile application integrating intelligent decisions based on simulations. The DEVS modeling aspects are implemented using the DEVSImPy Framework. The connected objects features are based on Phidgets. Phidgets offer a set of low-cost electronic components and sensors that are controlled by a personal computer.

Virtual Reality Interaction Using Mobile Devices

Sahar Aseeri, Daniel Acevedo-Feliz and Jurgen Schulze

Summary

With the use of an immersive display system such as CAVE system, the user is able to realize a 3D immersive virtual environment realistically. However, interacting with virtual worlds in CAVE systems using traditional input devices to perform easy operations such as manipulation, object selection, and navigation is often difficult. This difficulty could diminish the immersion and sense of presence when it comes to 3D virtual environment tasks. Our research aims to implement and evaluate alternative approaches of interaction with immersive virtual environments on mobile devices for manipulation and object selection tasks. As many researchers have noted, using a mobile device as an interaction device has a number of advantages, including built-in display, built-in control, and touch screen facility. These advantages facilitate simple tasks within immersive virtual environments. This research proposes new methods using mobile devices like Smart-phones to perform different kinds of interactions both as an input device, (e.g. performing selection and manipulation of objects) and as an output device (e.g. utilizing the screen as an extra view for a virtual camera or information display). Moreover, we developed a prototype system to demonstrate and informally evaluate these methods. The research conclusion suggests using mobile devices as a 3D-controller. This will be a more intuitive approach to interact within the virtual environment.

Roger Williams University PhysAssist

Brian Lee, Mark Fesenmeyer, Danielle Roche and Kevin Oliveira

Summary

After consulting several faculty members at Roger Williams University, our group decided upon making a companion application for an undergraduate Physics course. Our mobile application is to be used during the lab portion of the physics course, replacing the current software which is disliked by faculty. In order to replace the current software, our application should allow students to use their smartphones to record video of objects in motion. After recording, our application should also be able to compute various pieces of information about the objects such as distance traveled, velocity, or acceleration, and display such information graphically. We are working closely with our client Dr. Jennifer Pearce, a physics professor at Roger Williams University, in order to fully meet the needs of the physics faculty. In designing this companion application, we are focusing on three areas related to the 2015 competition—video processing, education, and science

Mobile Application Abstract

Alumni Connect at JMU

James Fencil, Connor Major, Robert Bolen and Samy El-Tawab

Summary

Alumni Connect is an iOS mobile application targeting social educational purposes that strengthens the connection between the “Integrated Science and Technology (ISAT) department alumni community” and ISAT students as well as faculty/staff. Our vision is to have ISAT alumni become more involved in the ISAT community specifically with undergraduate students. Our team designed and developed this idea after attending the 20th Anniversary of the ISAT department at James Madison University (JMU) April 2014. The mobile app gives users the opportunity to open up lines of communication that did not exist or was hard to do previously, leading to a more involved undergraduate student body. Alumni can search for fellow Alumni or Students that are using the Alumni Connect Application. Alumni can view or change any settings they feel necessary by using the settings tab. Alumni and Students have the capabilities of viewing the Alumni Feed, which contains job(s) opportunities, or posted events. The Alumni Feed is monitored by administration to prevent any inappropriate or unrelated posts.

Park at JMU

Dave Faliskie, Bradley White and Samy El-Tawab

Summary

The purpose of this application is to determine the number of available parking spots for a given parking lot. This mobile app is specific to the James Madison University campus and includes data for both parking decks and parking lots. The data is collected using a RFID sensor, which is included with a parking pass (RFID Tags). Below is the Architecture Diagram of the system. The mobile interface allows a user to select a specific parking lot then return the number of available spaces in a near-real time fashion. The Application allows a user to select a parking lot based on their current location or lots with the most open spots. The application will also have the ability to send notifications to the user when spots become available. There is a section showing the user peak time when the specific parking lot is full or empty. The application will be available on both iOS and Android as well as on the web. Below is an example of the alpha versions of the mobile applications on iPhone and Android.

Disaster Ambulance Decision Support System (DADSS)

Yu-Hsuan Lin, Shao-Jen Weng, Yeong-Yuh Xu, Tzu-Chian Chen, Kathleen Aprillia, Yu-Zhe Shi, Ling-Ling Li and Hsing-Yi Tsai

Summary

It is critical but difficult for decision-makers acquiring forecasts when disasters occur. APP is convenient for decision-makers inputting the estimated number of victims, the weight of disaster areas, and the total number of ambulance in the neighborhood. The module of disaster simulation, ambulance dispatch, and interaction with neighboring hospitals is constructed through the system. Besides, Particle Swarm Optimization (PSO) is utilized for searching the optimal ambulance allocation and combination to hospitals and assisting decision-makers in rapidly delivering the patients to the most proper hospitals with the average queue time so as to reduce the mortality rate, protect the public safety and health, and release the postponement of victim hospitalization.

Healthcare Network Decision Support System (HNDSS)

Yu-Hsuan Lin, Shao-Jen Weng, Yeong-Yuh Xu, Tzu-Chian Chen, Kathleen Aprillia, Yu-Zhe Shi, Ling-Ling Li, Hsing-Yi Tsai, Wei-Ming Wu, Hong-Hsun Chen and Jhe-Kai Lin

Summary

Emergency departments in the medical centers in Taiwan currently appear sickbed shortage that it is difficult to seek for a sickbed; or, to wait for a long period of time because of insufficient sickbeds is found after arriving in the emergency department of a hospital. The sickbed information of hospitals therefore needs to be clearly mastered. Such real-time information of sickbeds is extremely important when major disasters occur. For instance, when Kaohsiung gas explosion occurred, emergency departments were the reaction units at the first time. The records of the traffic jam for ambulances and the real-time number of sickbeds in hospitals could help the emergency medical technicians and personnel deliver patients to the hospitals with sufficient resources at the first time. Healthcare Network Decision Support System (HNDSS) is therefore established. It considers the dynamic procedure of a system, rapidly responds the dynamic sickbed information of hospitals to the network, and estimates the time to the hospitals so as to enhance the accuracy of sickbed information, confirm that the proportion of patients having sickbeds after arriving hospitals, and efficiently plan the resource allocation.

Mobile Application

Abstract

Mobile Application for Objective Measurement of Pectus Excavatum Vacuum Bell Treatment

Nahom Kidane, Salim Chemlal, Mohammad Obeid, Krzysztof Rechowicz, Frederic McKenzie and Robert Kelly

Summary

PectusExcavatum (PE) is the most common malformation where the sternum is displaced posteriorly and appears as sunken chest. Several non-surgical alternative methods are available, such as the vacuum bell which is widely used. The aim of our work is to develop a tool that allow off-the-shelf 3D scanning of the chest wall in pectus deformities and visualize the change in chest shape over the course of vacuum bell treatment. The proposed app allows 3D data collection using Microsoft Kinect for comparing pre and post treatment changes on mobile devices. This can increase motivation during active treatment, especially in children and younger adult patients.

Real-Time ECG Rendering on Mobile Devices for ECG-Based Virtual Pathology Stethoscope Tracking

Christopher Bliss, Dimitry Jacquet, Marvin Walker, Michael Kilmartin, Christopher Venning, Nahom Kidane, Salim Chemlal and Frederic McKenzie

Summary

The lack of bed patients' availability mandates the use of other cardiac examination (CE) training techniques, such as manikins. Sophisticated manikins are widely used for cardiac auscultation training; however, they lack the reality of patient interaction. Standardized patients (SPs), who are healthy individuals but trained to portray real patients, are also used for such training and other medical teaching techniques, but they are incapable of assuming conditions that result in audible heart defects on command. Current research involve a novel tracking method for placing virtual symptoms in auscultation areas based on recorded ECG signals, allowing the trainees to hear abnormal heart and lung sounds in healthy patients-- such as SPs. The proposed app allow real-time ECG data collection and rendering on mobile devices. The app compliments the ECG-based virtual pathology stethoscope; after plotting ECG signals, the app will classify and distinguish the different auscultation areas for further CE training.

Mobile Simulation: Bringing Simulations to Smartphones

Mohammad Etemad, Sixuan Wang and Gabriel Wainer

Summary

We introduce a new approach to running simulations on mobile devices. We discuss how to use Cloud servers to overcome some limitations that may be faced by using smartphones as simulation devices.

Modeling and Simulation in Medicine

Abstract

Models in Healthcare Simulation: Typology and Security Issues

Jerzy Rozenblit and Johannes Sametinger

Summary

This paper is a “call for action” to formalize the typology of models used in healthcare simulation models. A brief taxonomy of model types is presented. Issues of model correctness and security are brought to the fore, to illustrate the challenges in this field. Examples are given that further highlight the research and development challenges.

Modeling Clinical Data from Publications

Jacob Barhak

Summary

Medical data is becoming increasingly available. Access to such data is generally restricted and researchers cannot access it easily. On the other hand, clinical trial data is freely available and published without restriction for access to the public at the summary level. With proper analysis, it is possible to extract valuable conclusions from such data. This paper will review new methods to look at such public data and will discuss possible future trends.

Rule-based Modelling and Simulation of Drug-Administration Policies

Luca Bortolussi, Thilo Krüger, Thorsten Lehr and Verena Wolf

Summary

We consider rule-based models extended with time-dependent reaction rates, a suitable formalism to describe the effect of drug administration on biochemical systems. In the paper, we provide a novel and efficient rejection-based simulation algorithm that samples exactly the trajectory space of such models. Furthermore, we investigate a model of drug administration in the context of a plaque-formation process of Alzheimer’s disease, a polymerization process best described by a rule-based model to counteract the intrinsic combinatorial explosion of the underlying reaction network. Furthermore, time-dependent rates are needed to model the effect of drugs. We apply the simulation algorithm to study the efficacy of different drug administration policies.

Reducing Length of Stay of Patients in an Outpatient OB Clinic - a Simulation Approach

Hari Eswaran, Curtis Lowery, Brandon McVay, Camille Dollins and R.B. Lenin

Summary

In the health care industry, a pressing issue is the need to assess and analyze care services in order to ensure efficient and quality care. For outpatient clinics, length of stay of patients is an important performance measure in helping to determine service quality. The Community Women's Clinic associated with the University of Arkansas for Medical Science is a practice dedicated to providing outpatient obstetrics care including high risk pregnancy. In this study, we develop an appointment template driven simulation model of the clinic, validate the model, and run several “what-if” scenarios to identify optimal number of staff to minimize the length of stay of patients in the clinic. The best scenario of adding one advanced practice nurse, one patient care technician, and one additional capacity in the non-stress test room improved the length of stay of patients for the entire clinic by 19% and for the high risk patients by 10%. We achieved these improvements without affecting the actual clinic activities which the clinic management had difficulty in achieving through many manual interventions.

Simulating the Expected Net Benefits of Health Research: The Case of Randomized Clinical Trials for Comparing the Effects of Two Health Interventions

Ismail Abbas

Summary

Introduction: This paper presents a simulation model of clinical trials that incorporate additional information on cost and health outcomes of two health interventions, society contribution, and cost of research, prior sample size and power. The simulation addresses whether from private and public perspectives it would be worthwhile to conduct a clinical trial, considering the expected net benefit for the health system. **Methods:** Considering a clinical trial for comparing two health interventions that evaluate the health of stroke patients, the overall expected net benefits model is evaluated using hypothesis testing by two approaches: clinical trial and population simulation. Both approaches were performed using statistical formulas and intensive simulations. The probability of standardized expected net benefits can be predicted to aid making decision under a variety of reasonable settings. **Results:** Two decisions can be made assuming the new intervention is dominant or has an incremental effect from cost-effectiveness perspective. 1) As the null hypothesis can be rejected when it is true and the probability of expected net benefits increases beyond the minimal value of society contribution, conducting trial is worthwhile from public health perspective. 2) As the null hypothesis can be rejected when there is a minimal difference and the probability of expected net benefits increases beyond the corresponding society contribution, conducting trial is advisable from private health perspectives, in which case the sample size of the trial can be optimized. **Discussion:** Simulation modelling predicts valuable information supporting private and public health researchers and decision makers of clinical trials. Future research will extend the model to multi-center multi-stages clinical trials.

Modeling and Simulation in Medicine

Abstract

Interactive Multi-Physics Simulation for Endodontic Treatment Sebastian von Mammen, Marco Weber, Hans-Heinrich Opel and Timothy Davison

Summary

In this paper we present a novel approach to simulating dental treatment of root canals. Preceding interactive simulation approaches to dental training focus on preparing access cavities and working on the hard dentin of a tooth. Their common goal is to provide haptic feedback necessary to impart manual dexterity to students. In contrast, we focus on learning about the intricate complexity involved in root canal treatment, considering different root canal morphologies, differences in the texture of the pulp tissue as well as the interaction possibilities offered by different dental instruments at individual steps of the procedure. Due to this shift in focus, new challenges of computing appropriate physical interactions emerge. In this paper we elaborate on recent developments in realtime physics simulation and we demonstrate the backend mechanisms needed to drive more complex dental training simulations, amalgamating different representations for real-time physics calculations.

Haptic Guidance with Fuzzy Control in Simulation-based Surgical Training Minsik Hong and Jerzy Rozenblit

Summary

This paper describes a haptic guidance system developed to assist in model-based training of minimally invasive, laparoscopic procedures. The key factor motivating the development of the device called CAST (Computer-Assisted Surgical Trainer) is the need to improve the state-of-the-art in teaching laparoscopy, and ultimately improve surgical outcomes. CAST's exchangeable task scenario and fuzzy logic controller with reference generator are presented. The system, while currently intended for off-line, laboratory use, has an excellent potential for real-time assistive functions in the operating room.

Novel Force Feedback Interface for Improving Human Perception in Laparoscopic Surgical Trainer

Jan Nikodem and Ryszard Klempous

Summary

This paper considers interaction of the laparoscopic instrument with virtual objects simulated in minimally invasive surgery trainer, which is a complex device which requires a synthesis between visual and haptic information. To compute the point-to-point interaction forces between the laparoscopic instrument and human internal organs, the software graphic data processing algorithms can be implemented. Inspired by the idea of Haptic Virtual Objects and virtual reality architecture, incorporated visual and haptic feedback, we employ virtual reality (VR) software for detection of collision between soft and rigid body, and soft body deformation. VR physics engine apply a force to each vertex of a triangle tessellated mesh, so as a result we obtain from VR physics rendering engine ready to use force vectors. To obtain that, first we create computer-generated Haptic Virtual Objects (HVO), which can be touched and manipulated with laparoscopic instruments. Next, we employ specific rendering engine working on physical interactions. In proposed software (written in C++) we employ HVO and OGRE 3D graphic rendering and Bullet Physics engines. It calculates a force feedback for yaw, pitch and insertion axes of motion. Force rendering algorithm considers point-based interactions, and the force rendering loop update rate is about 100Hz.

Simplex-based Surface and Contour Models for Segmentation and Meshing for Surgery Simulation

Michel Audette, Rabia Haq, Tanweer Rashid and Sharmin Sultana

Summary

Medical simulation generally requires at least two types of model: one each for the anatomy and therapy. Generally, the anatomical modeling requires separate algorithmic stages for segmentation, which maps voxel intensities from MRI/CT to tissues, and meshing, which decomposes tissues into simple shapes conducive to therapy simulation. This paper describes techniques under development that can both improve the robustness of the segmentation and simplify the meshing: 3D active simplex surface and contour models. A n -simplex is characterized as a mesh with $n+1$ connectivity: a 2-simplex produces a surface mesh where every vertex is linked by edges to 3 neighboring vertices, dual to triangulated mesh, while a 1-simplex produces a contour model with every vertex linked to two vertices. The 2-simplex is already well-published, and is used in conjunction with a Newtonian model of the vertex motion, based on the application of both internal and external forces: the internal forces generally impose model behavior encompassing surface continuity while the external forces include a balloon-like inflation force as well as an image-based stopping force. The final simplex surface mesh can then anchor subsequent tetrahedral meshing. Modifications to this 2-simplex in the literature include the application of a shape statistics force derived from a population of anatomical equivalents, as well as multi-surface modeling with resolution control and static collision detection, which prevents proximate surface models from overlapping each other spatially. Our improvements to simplex modeling, in conjunction with neurosurgery simulation research, include the combination of shape statistics and multi-surface modeling in the 2-simplex for spine surgery simulation, a 2-simplex with shared boundaries based on multi-material contouring for representing a deep-brain atlas as a multi-surface mesh and enabling real-time brain shift estimation in robotic deep-brain stimulation, and a 1-simplex contour model for modeling cranial nerves emanating from the brainstem, close to cerebrovasculature.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

System for Tracking and Visualizing Social Interactions in a Collaborative Work Environment

Mani Williams, Jane Burry, Asha Rao and Nathan Williams

Summary

This paper presents our work on indoor tracking and demonstrates its capacity as a data collection system for the study of socio-spatial interactions that occur in a collaborative work environment. Deployed at a recent week-long international design workshop, our system was able to track the movements of more than fifty people from various roles, and generate live visualizations. In this paper we will present the data collection system and the system configurations, the complete dataset collected and sample visualization scripts to stimulate further research in the area of people interaction study and its relation to spatial usage.

Simulating Human Behavior in Not-yet Built Environments by Means of Event-based Narratives

Davide Schaumann, Yehuda E. Kalay, Seung Wan Hong and Davide Simeone

Summary

Current Computer-Aided Architectural Design (CAAD) systems fail to represent buildings in-use before their realization. This failure prevents testing the extent to which a proposed setting supports the activities of its intended users. We present a novel approach to human behavior simulation based on a thorough representation of end-user activities by means of events – computational constructs that simulate users' individual and group activities to achieve a specific goal. Human behavior narratives result from a combination of top-down (planned) and bottom-up (unplanned) sequences of events, as a reaction to time-based schedules and to social and environmental stimuli, respectively. A narrative management system orchestrates the narrative developments and resolves conflicts that may arise among competing events.

Approaching Biomimetics: Optimization of Resource Use in Buildings Using a System Dynamics Modeling Tool

Mercedes Garcia-Holguera, Grant Clark, Aaron Sprecher and Susan Gaskin

Summary

The biomimetic field in architecture is developing tools for transferring processes and functions from biological systems to buildings. Buildings, like ecosystems, are dynamic and complex systems, thus studying their dynamics from a systems thinking perspective might bring insight to some environmental problems. STELLA®, a software commonly used to model environmental dynamics, was used to identify approaches for energy optimization in the Great River Energy Building. Long-term energy flows and thermal properties of the building were modeled to understand the feedback loops that control the behavior of the building system. The simulation showed that optimization of passive building parameters produced considerable energy savings, but more active strategies would be necessary to make the Great River Energy building a net-zero energy building. This exercise showed how the STELLA® software can represent the dynamic behavior of buildings as well as the dynamic behavior of environmental systems, and the potential of this tool for biomimetic research in architecture.

A New Approach to Modeling Frit Patterns for Daylight Simulation

Mostapha Sadeghipour Roudsari and Anne Waelkens

Summary

With recent progress in the development of affordable and faster digital design techniques and production methods, as well as the rising demand for buildings with better thermal and visual comfort, the use of frit patterns is becoming more common. There is a great diversity of fritted materials, but there are limited highly technical solutions for evaluating the effects of using these materials. This paper introduces a custom workflow for modeling frit patterns for daylight simulation on buildings, which streamlines quantitative and qualitative daylight analysis by using parametric modeling tools such as Grasshopper3D, in association with validated lighting rendering engine Radiance. The presented method was applied to a real-world project with custom ETFE facade elements and complex geometries to explain the capabilities of the workflow.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

Development of a Modeling Strategy for Adaptive Multifunctional Solar Energy Building Envelope Systems

Nicholas Novelli, Justin Shultz and Anna Dyson

Summary

To achieve significant progress towards global targets for clean on-site energy self-sufficiency within the building sector, the integration of adaptive high efficiency solar collection systems into building envelope systems could offer broad additional benefits beyond power generation, such as: daylighting, hot water heating and purification, thermal comfort control, energy use reduction through lowered lighting and cooling loads, and tie-ins to direct current (DC) microgrids. Dramatic system efficiencies could be achieved with multifunctional envelopes by coupling to building systems to respond to fluctuations in weather and building use patterns. The development of active building envelope systems is impeded by current modeling workflows which do not provide adequate feedback or facilitate rapid design iteration within the context of building energy modeling (BEM). A simulation environment, Modelica, has purported extensibility and ease of co-simulation through the functional mock-up (FMI) standard. This environment is evaluated here through the development of a model for a novel multifunctional building envelope system, with concentrating photovoltaic and thermal collectors (BITCOPT) that incorporates multiple active and passive energy strategies simultaneously, while providing architectural benefits such as increased transparency and connection to views. The model is calibrated with measured data from an experimental prototype and is used to extrapolate the system's theoretical power generation and energy efficiency effects. The simulation environment did indeed facilitate extensible model construction, encouraging future work to be pursued in co-simulation of the model with BEM via the FMI standard. The model structure, correlation to measured data, extrapolated results and future work are described here.

A Physical and Numerical Simulation Strategy to Understand the Impact of the Dynamics in Air for the Design of Porous Screens

Mani Williams, Rafael Moya, Daniel Prohasky, Mehrnoush Latifi Khorasgani, Simon Watkins, Mark Burry, Jane Burry and Philip Belesky

Summary

This paper describes a virtual and physical design and prototyping strategy intended to aid designers to understand the relational dynamic between airflow and porous screens for building facades at the conceptual design stage. The strategy consists of three main components: 1) A prototyping phase involving a combination of computer aided modeling (CAM), physical additive and subtractive fabrication; 2) A virtual simulation phase using computational fluid dynamics (CFD) software; 3) A physical simulation phase of experimental fluid dynamics (EFD) using a miniature wind tunnel (MWT) and microelectronic measurement systems (MEMS) that measure: wind speed, air temperature and relative humidity. The design strategy supports the designer to make design decisions based on relevant feedback from both CFD and EFD methods – covering a vast design solution space. The tools utilized within this design strategy are presented as a kit containing parts that are relatively inexpensive, easy to assemble, and have been successfully user-tested at an international design workshop. The paper includes the description of the application of the strategy combining CFD, MWT, MEMs and real time visualization to the design and study of various porous screens produced during the design workshop.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

Exploratory Sequential Data Analysis for Multi-Agent Occupancy Simulation Results

Simon Breslav, Rhys Goldstein, Azam Khan and Kasper Hornbæk

Summary

In this paper we apply the principles of Exploratory Sequential Data Analysis (ESDA) to simulation results analysis. We replicate a resource consumption simulation of occupants in a building and analyze the results using an open-source ESDA tool called UberTagger previously only used in the human-computer interaction (HCI) domain. We demonstrate the usefulness of ESDA by applying it to a hotel occupant simulation involving water and energy consumption. We have found that using a system which implements ESDA principles helps practitioners better understand their simulation models, form hypotheses about simulated behavior, more effectively debug simulation code, and more easily communicate their findings to others.

Capturing an Architectural Knowledge Base Utilizing Rules Engine Integration for Energy and Environmental Simulations

Holly T. Ferguson, Charles F. Vardeman II and Aimee P. C. Buccellato

Summary

The era of "Big Data" presents new challenges and opportunities to impact how the built environment is designed and constructed. Modern design tools and material databases should be more scalable, reliable, and accessible to take full advantage of the quantity of available building data. New approaches providing well-structured information can lead to robust decision support for architectural simulations earlier in the design process; rule-based decision engines and knowledge bases are the link between current data and useful decision frameworks. Integrating distributed API-based systems means that material data silos existing in modern tools can become enriched and extensible for future use with additional data from building documents, other databases, and the minds of design professionals. The PyKE rules engine extension to the Green Scale (GS) Tool improves material searches, creates the opportunity for incorporating additional rules via a REST interface, and enables integration with the Semantic Web via Linked Data principles.

A Digital Design and Fabrication Library **Stylianios Dritsas**

Summary

The goal of our system, for lack of better name at moment named as Alpha, is to offer an integrated approach to digital design and fabrication with capabilities beyond computer aided design and manufacturing. We attempt this to identify new modes of digital design thinking and to address the broader picture, that is, the challenge of translating between design and its production. It is to understand the complexity of design and its implications in production, to enable and perform architectural design analysis, rationalization and design performance optimization. We integrate visual: geometric modeling and simulation components; and non-visual: mathematical modeling and numerical optimization techniques. The intended audience at the current early stage of development is the research community in digital design and fabrication and design education with later goal of expanding to production.

Self-Organizing City: Experiments using Multi-Agent Model and Space Syntax **Ming Tang**

Summary

This paper describes a process of using local interactions to generate intricate global patterns and emergent urban forms. Starting with network topology optimization, agent-based model (ABM) is used to construct the micro-level complexity within a simulated environment. The authors focus on how agent-driven emergent patterns can evolve during the simulation in response to the "hidden hand" of macro-level goals. The research extends to the agents' interactions driven by a set of rules and external forces. An evaluation method is investigated by combining network optimization with space syntax. The multi-phase approach starts with defining the self-organizing system, which is created by optimizing its topology with ABM. A macro-level "attraction map" is generated based on space syntax analysis. Then the map is used to control various construction operations of an adaptive urban model.

Occupant-Aware Indoor Monitoring for Enhanced Building Analysis

Dimosthenis Ioannidis, Stelios Krinidis, Anastasios Drosou, Dimitrios Tzovaras and Spiridon Likothanassis

Summary

In this paper a novel, cost-effective and robust occupancy monitoring system is presented, which is based on a fuzzy confidence voting algorithm utilizing spatial height histograms. Spatial height histograms are invariant to rotations and translations, providing this way a desirable feature to occupancy measurement systems, and when combined with distance coefficients can fix an occupancy feature vector, which is the main source for the fuzzy confidence voting occupant tracking algorithm. The proposed occupancy extraction system can be efficiently applied to multi-space environments using a privacy preserving multi-camera cloud. Statistics per building, space and occupant can be finally extracted by the system. The experimental results will illustrate its robustness, accuracy and efficiency on occupancy extraction.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

Decomposition Strategies for Building Envelope Design Optimization Problems

Steve Barg, Forest Flager and Martin Fischer

Summary

The design of a building's envelope, including exterior walls, glazing and shading elements, has a significant impact on the life-cycle cost and environmental impact of the facility. Computational Design Optimization (CDO) methods have been developed to assist architects and engineers to systematically search through large numbers of design alternatives to identify high-performing building envelope solutions. This paper presents a method to quantitatively compare different CDO approaches in terms of solution quality and computational efficiency. To demonstrate the method we compare four CDO methods: two single-level genetic algorithms, a single-level gradient-based algorithm that maps continuous solutions back to discrete options, and a bi-level decomposition with a gradient-based algorithm operating on continuous variables nested within a genetic algorithm operating on discrete variables. The example chosen for benchmarking purposes is a midrise apartment building in Chicago. The results show that the all-in-one multiple objective genetic algorithm is the most computationally efficient and produced superior solution quality. The limited breadth of the current results does not allow general conclusions about the methods, but does demonstrate a methodology for further evaluation of optimization techniques.

Optimization of Passive Cooling Control Thresholds with GenOpt and EnergyPlus

Alexandra R. Rempel and Stephen J. Remington

Summary

Passive cooling strategies (e.g. shading, natural ventilation, use of thermal mass) can effectively reduce a building's cooling load during hot summer weather. Such techniques have been well-studied, with the provision that precedent work assumes operable shading devices, windows, and vents are operated according to pre-determined schedules or setpoints. This work, in contrast, investigates numerical optimization of the setpoints themselves. Among space types most useful for studying passive cooling are unconditioned zones such as sunspaces, because they can easily overheat on sunny days and because heat loss pathways in the forms of wind, cool night air, cold night skies, ground contact, and precipitation can sum to a sizable proportion of the cooling load in temperate climates. At the same time, the transition of a given path between heat gain and loss may be undetectable to an occupant, causing manual controls to be ineffective and mechanical controls to be of interest. Here, GenOpt was used to manage optimizations of shading and natural ventilation control thresholds, as well as auxiliary optimizations of shading type, material, and position; vent area; and thermal mass quantities, within a field-validated EnergyPlus sunspace model. Results predicted that controls operated according to optimized setpoints should maintain peak indoor temperatures 8-10°C (14-18°F) below outside air temperatures during the hottest August afternoons of the sunspace's native American Pacific Northwest climate. In addition, optimization data established clear priorities among field configurations to be tested, showing the potential to simplify subsequent field validation greatly.

ComfortCover: A Novel Method for the Design of Outdoor Shades **Christopher Mackey, Mostapha Sadeghipour Roudsari and Panagiotis Samaras**

Summary

Over the past few decades, several methods for designing shades to reduce energy loads of buildings have emerged. However, to date there are virtually no agreed upon methods available to assist in the design of outdoor shades to keep people comfortable. Here we present a novel method named ComfortCover to assist in the design of static shades in outdoor conditions using a 3-step methodology adapted from the current state-of-the-art process for the design of building shades. The first step is an assessment of radiation falling on a person and the calculation of a corresponding solar-adjusted radiant temperature for every hour of the year. Second, this temperature is fed into an hourly calculation of Universal Thermal Climate Index (UTCI). Lastly, this UTCI is fed into an algorithm that projects sun vectors for every hour of the year from the location of a person through a surface where shade design is being considered. Each of the vectors is associated with a UTCI and a temperature difference from a 'comfort temperature' that is summed up for every subdivision of the test shade to color it with shade helpfulness (blue), shade harmfulness (red) and no major effect of shade (white).

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Abstract

Toward Pre-Simulated Guidelines for Low-Energy High-Rise Residential Design in Megacities

**Holly Samuelson, Apoorv Goyal, Sebastian Claussnitzer, Alejandra Romo-Castillo, Yujiao Chen and
Arpan Bakshi**

Summary

In order to improve early decision-making for similar projects, the authors used parametric energy simulation with the eventual aim of providing pre-design guidance for multiple teams of architects and policy-makers. The authors investigated high-rise, multi-family residential buildings in three megacities as case studies. They tested the impact of various design parameters on different energy objectives that they anticipate including in their pre-design resource. The research included three parts. (1) The authors identified synergies and trade-offs, in terms of early design decisions, when designing for different energy objectives, including (a) reducing annual energy consumption, (b) shaving peak-energy demand, and (c) increasing passive survivability – i.e., maintaining the safest interior temperatures in an extended power outage. (2) They performed sensitivity analyses to identify the impact of various design parameters – which included building form, window-to-wall ratio, envelope construction, shading design, and others – in the presence of confounding variables such as varying internal loads. (3) The authors investigated the impact of urban context. Since in generalized guidelines the future building site is unknown, the authors tested a method for generating an urban context based on the floor area ratio and maximum building heights of an urban district. These tests support the larger idea of eventually creating a comprehensive, pre-simulated resource for pre-design.

Optimizing Creatively in Multi-Objective Optimization

Yassin Ashour and Branko Kolarevic

Summary

Designers will always face the challenge of designing well-performing buildings using what are often conflicting and competing objectives. Early stage design decisions influence significantly the final performance of a building and designers are often unable to explore large numbers of design alternatives with respect to the performative criteria set for the project. This research outlines a ‘creative optimization workflow’ using a Multi-Objective Optimization (MOO) engine called Octopus that runs within Grasshopper3D, a parametric modeling tool, and simulation software DIVA for daylight factor analysis. The workflow utilizes a ‘creative optimization tool’ which allows the designer to explore, sort and filter solutions, and analyze both quantitatively and qualitatively the trade-offs of the resultant design solution space. It enables the designer to visually compare alternative solutions in a gallery and subsequently analyze trade-offs through a radar-based chart, parallel coordinate plot graphs and conditional domain searches. This feedback tools allows the designer to quickly and efficiently identify potential solutions for either design development or to select preferred solutions for further optimization, i.e. ‘optimizing creatively’. A retrospective design case study, the ‘De Rotterdam’ building, is used to demonstrate the application of the tools. The workflow demonstrates the ability to reduce design latency and to allow for better understanding of design solutions. Additional research is needed to better understand the application of MOO in the early stages of design; and the further improvement of the creative optimization tools to accommodate the designer’s need for a more dynamic and synergistic process.

Forensically Discovering Simulation Feedback Knowledge from a Campus Energy Information System

Clayton Miller and Arno Schlueter

Summary

Simulation model calibration has been long identified as a key means of reconciling the consumption and efficiency characteristics of buildings. A key step in this process is the creation of the actual diversity factor profiles for occupancy and various energy end uses such as lighting, plug-loads, and HVAC. Creation of these model inputs is conventionally a tedious process of site surveys, interviews or temporary sensor installation. Sometimes measured energy data can be used to create these schedules, however there are many challenges, especially when the sensor network available is large or unorganized. This paper describes a process applying a series of knowledge discovery filters to screen data quality, weather sensitivity, and temporal breakouts from large nonresidential building performance datasets collected by building management and energy information systems (BMS/EIS). These screening techniques are used to qualify the desirability for calibrated model diversity schedule creation from a forensic perspective. A diurnal pattern filtering technique is then applied that automatically extracts frequent daily performance profiles, which can then be normalized and used as model inputs according to conventional industry techniques. The process is applied on a raw dataset of 389 power meter data streams collected for eight years from the EIS of a campus of 32 higher education buildings. The results are discussed in the context of time and effort savings for creating urban and building scale simulation model inputs.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

Analyzing Indoor Comfort Conditions through Simulation and On-Site Measurements Raghuram Sunnam, Annie Marston, Zhuzhou Fu and Oliver Baumann

Summary

ASHRAE standard 55-2013 defines thermal comfort of occupants as a mental state of satisfaction with regard to the thermal environment. Mechanical designers design HVAC systems to condition an occupied space so as to provide thermal comfort to at least 80% of the occupants. Thermal comfort is dependent on various physiological and psychological aspects of the occupants and it is defined by ASHRAE standard 55 based on – 1. Metabolic rate, 2. Clothing insulation, 3. Air temperature, 4. Radiant temperature, 5. Air speed, 6. Humidity. This paper presents the thermal comfort study of five conference rooms in the ground level of a 16 story office building in Frankfurt. The conference rooms are conditioned by a direct outdoor air system (DOAS) and radiant ceiling panels for cooling and heating. This paper discusses the modeling approach and the simulation results that were used by the project team to determine the additional cooling capacity needed by the conference rooms. The simulation results were used to make informed decisions about the number of chilled beams required in the conference rooms. Further, the measurements recorded on the site during the commissioning process were used to compare against the simulation results.

Computing Curved-Folded Tessellations through Straight-Folding Approximation Suryansh Chandra, Axel Körner, Antiopi Koronaki, Rachele Spiteri, Radhika Amin, Samidha Kowli and Michael Weinstock

Summary

The research presented in this paper explores curved-crease tessellations to manufacture freeform geometries for architectural and industrial design. The work draws inspiration from the ease of shaping paper into double-curved geometries through repeating fold patterns and the observed stiffening of curved surfaces. Since production of large scale curved-folded geometries is challenging due to the lack of generalised methods, we propose an interactive design system for curved crease tessellation of freeform geometries. The methods include the development of curved folding patterns on the local scale as well as a novel computational method of applying those patterns to polysurfaces. Using discretized, straight-line fold approximations of curved folds in order to simplify computation and maintain interactivity, this approach guarantees developable surfaces on the local scale while keeping the double curved appearance of the global geometry.

((MODYPLAN)) - Early-Stage Hospital Simulation with Emphasis on Cross-Clinical Treatment Chains

Gabriel Wurzer, Wolfgang E. Lorenz, Matthias Rössler, Irene Hafner, Niki Popper and Barbara Glock

Summary

Health trusts are aiming to consolidate the clinical landscape: The provision of medical services, now handled by individual clinics, is to be transformed such that the patient volume can be redirected between different specialized service providers. As implication, hospital planning needs to embrace the subject of cross-clinical development rather than looking at each facility in isolation. In this context, we have been developing ((MODYPLAN)), a cross-clinical simulation for early-stage architectural planning. Our software takes the patient volume as input and redirects it to different facilities, each one having a different spatial layouts and treatment capacity. As outputs, we obtain the utilization and occupancy of each service unit on which we can base further analysis concerning bottlenecks. Furthermore, different configurations of the clinical landscape can be compared, facilitating a multi-faceted discussion among stakeholders (clinical providers, their staff and patients). As audience, we target hospital administration, architects and process designers preparing or working on tenders. Such an early application of cross-clinical simulation is, to the best of our knowledge, yet unprecedented.

Simulating Human Visual Experience in Stadiums Roland Hudson and Michael Westlake

Summary

In this paper we describe progress to date of software that simulates occupant experience in high capacity sports venues. Our simulation aims to provide metrics that indicate quality of view, and in doing so generates data that indicates levels of human comfort. This approach enables the design process to be driven from the perspective of the occupant. In particular we implement a novel means of simulating and expressing quality-of-view that addresses deficiency's in the standard method of describing view quality. Visualisation of the simulation output is via an online 3D viewer shared with the entire design team. Views from any seat location can be inspected and data fields from the simulation can be compared. Data is represented with colour scales bound to a 3D seating bowl model. Using simulation to understand spectator experience from within a 3D environment challenges the validity of traditional design approaches that are based on two-dimensional thinking and drafting board logic. Our simulated study of view quality enables us to consider revisions to these traditional techniques which could lead to more spatially efficient seating facilities. Increasing spectator density is believed to enhance atmospheric qualities, this combined with better views will contribute towards an improved occupant experience.

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Abstract

Assessing the Energy and IAQ Potential of Dynamic Minimum Ventilation Rate Strategies in Offices

César Porras-Amores and Spencer Dutton

Summary

The energy and Indoor Air Quality (IAQ) implications of varying monthly minimum ventilation rates (VRs) in California offices were assessed using EnergyPlus and its integrated multi-zone contaminant modeling feature to predict HVAC energy use and average indoor concentrations of formaldehyde. Minimum mechanical ventilation rates were varied monthly: rates were lowered below Title 24 prescribed values for months when the energy penalty of providing ventilation air was highest; rates were raised during temperate months. For each of California's sixteen climate zones numerical methods identified the optimal combination of monthly ventilation rates that both lowered annual HVAC energy use and maintained average annual formaldehyde exposure below specified levels. Reference models used the fixed minimum ventilation rates prescribed in California's Title 24 Standard. In buildings without economizers, optimal monthly strategies reduced total HVAC energy consumption up to 21.7% and reduced indoor formaldehyde concentrations up to 44%. The benefits in buildings with economizers were much smaller with a maximum energy savings 0.3%. In temperate climates, in buildings without economizers, increasing ventilation rates all year round reduced annual contaminant exposures and lowered annual HVAC energy. A secondary benefit of the optimal variable ventilation strategy was a reduction of peak cooling electricity up to 17% in hotter climates.

Multiobjective Optimization of Structure and Visual Qualities

Kirk Martini

Summary

The paper describes and demonstrates an optimization tool that combines methods developed independently in the fields of structural engineering and fine art. Optimization has a long history in structural engineering. Most commonly, structural optimization seeks a configuration that minimizes material volume, subject to constraints on strength and stiffness. Metaheuristic search methods, such as genetic algorithms, have been widely applied to structural optimization problems. Such methods have also been applied in the field of evolutionary art. This field seeks to produce aesthetic images or objects through an iterative search, guided by visual, rather than functional objectives. The paper presents the Variable Evolutionary Strategy for Pareto Optimization (Vespo), and demonstrates its use to integrate visual objective functions like those in evolutionary art with technical objective functions and constraints in structural optimization. The goal is to aid a designer in developing an efficient structure with desired visual qualities. The work is motivated in part by the prominent trend in contemporary architecture toward randomized, free-form structures.

Multi-Objective Genetic Algorithms for the Minimisation of the Life Cycle Carbon Footprint and Life Cycle Cost of the Refurbishment of a Residential Complex's Envelope: A Case Study

Yair Schwartz, Rokia Raslan and Dejan Mumovic

Summary

Life Cycle Analysis (LCA) is an environmental assessment and management framework that aims to simplify the decision-making processes of manufacturing and consumption, with regard to their environmental impact. In the built environment, LCA is often used as a comparative tool that helps in choosing one design alternative over another. Most LCA studies compare a limited number of design alternatives due to the complexity of the method. The main goal of this study is to examine the various Life Cycle aspects of a refurbishment of a case study, and explore the potential of using Multi Objective Genetic Algorithms (MOGA) with Dynamic Thermal Simulation Tool (EnergyPlus) to find optimal refurbishment measures in terms of Life Cycle Carbon Footprint (LCCF) and Life Cycle Cost (LCC) over an assumed life span of 60 years. Results show that MOGA successfully identified optimal design solutions, when taking into account both basic design aspects such as window-to-wall ratio or envelope build-ups, but also more detailed ones, such as thermal bridges insulation and the use of different fuel types for energy generation.

A Comparative Study of Mixed Mode Simulation Methods: Approaches in Research and Practice

Priya Gandhi, Gail Brager and Spencer Dutton

Summary

This project explores how both researchers and practitioners use simulation methods for naturally-ventilated and mixed mode buildings. A focused literature review was conducted to outline the modeling tools and methods used by researchers, including appropriate tools and the importance of site-specific wind data and accurate wind pressure coefficients. The literature review also summarized research on window opening behavior, noting that there is little practical guidance for practitioners interested in related stochastic modeling techniques. The second phase of the project involved conducting interviews with practitioners who model naturally-ventilated and mixed mode buildings. Practitioners reported that they would like to see more integrated tools, tools with improved result visualizations, and early-phase design tools.

Symposium on Simulation for Architecture and Urban Design (SimAUD)

Abstract

A Multi Agent Systems for Design Simulation Framework: Experiments with Virtual Physical Social Feedback for Architecture

David Jason Gerber, Evangelos Pantazis, Leandro Marcolino and Arsalan Heydarian

Summary

This paper presents continuing research on the development of multi-agent systems (MAS) for integrated and performance driven architectural design. It presents the development of a research framework that bridges architecture and engineering, through a series of simulation based experiments. The research is motivated to combine multiple design agencies into a system for managing and optimizing intricacy across complex architectural form, on objectives and contexts. The research anticipates the incorporation of feedback from real world human behavior and user preferences with physics based structural form finding and environmental analysis data. The framework is a multi-agent system that provides design teams with informed design solutions, which simultaneously optimize and satisfy competing design objectives. The initial results of the multi-agent systems approach for building structures- hypothetical and real- are measured in terms of the level of lighting improvements and qualitatively in geometric terms. Critical to the research is the elaboration of the system and the feedback loops that are possible in using the multi-agent systems approach.

Aware Design Models

Martin Tamke

Summary

Appearing almost alive, a novel set of computational design models can become an active counterpart for architects in the design process. The ability to loop, sense and query and the integration of near real-time simulation provide these models with a depth and agility that allows for instant and informed feedback. Introducing the term “Aware models”, the paper investigates how computational models become an enabler for a better informed architectural design practice, through the embedding of knowledge about constraints, behaviour and processes of formation and making into generative design models. The inspection of several computational design projects in architectural research highlights three different types of awareness a model can possess and devises strategies to establish and finally design with aware models. This design practice is collaborative in nature and characterized by a bidirectional flow of information. The concept of the aware model addresses hence the current infrastructures of digital design models and processes, which impede technologically and methodologically feedback between disciplines and processes.

Curve-Folded Form-Work for Cast, Compressive Skeletons

Shajay Bhooshan, Vishu Bhooshan, Ashwin Shah, Henry Louth and David Reeves

Summary

The research described in this paper explores the synergy between the methods of form-finding (for funicular loads) with curved -crease folding (CCF). The paper will propose a two-step process that combines a form-finding method that finds the form under vertical loading and with a mesh-perturbation method that solves for planarity and develop-ability constraints. The resulting geometry will be shown to be amenable to construct curve-crease folded moulds for concrete casting. The paper will also describe the design of a demonstrative prototype - a self-supporting structure composed of bar-elements that are formed by casting concrete into molds that are curve-folded from sheet material.

Remote Solving: A Methodological Shift in Collaborative Building Design and Analysis

Matthew R. Naugle and Mostapha Sadeghipour Roudsari

Summary

This paper presents a cross-disciplinary design workflow utilizing automated computation as a means for enabling rapid design and engineering collaboration between architecture engineering and construction (AEC) project teams. The workflow, known as Remote Solving, connects digital design models to remotely hosted bespoke engineering analysis engines to provide near real-time engineering feedback. This workflow fundamentally changes the way design and engineering practices may communicate information, resulting in design solutions that embody a fully integrated approach to design and engineering in digital practice. The paper provides an understanding of the fundamental technologies and methodologies that constitute a Remote Solving workflow alongside a case study demonstrating a prototype project designed to leverage this method of collaboration.

Symposium on Simulation for Architecture and Urban Design (SimAUD) Abstract

Digital Campus Innovation Project: Integration of Building Information Modelling with Building Performance Simulation and Building Diagnostics

Zixiao Shi, Aly Abdelalim, William O'Brien, Ramtin Attar, Peter Akiki, Katie Graham, Barbara Van Waarden, Steve Fai, Alex Tessier and Azam Khan

Summary

Building Information Modelling (BIM) has emerged as a powerful technology that creates a central hub for managing building energy and resources at all phases of the building life cycle. Without it, many tools that lack interoperability are used, thus massively under-exploiting the efforts of other building design and management parties; this largely describes the status quo. However, despite the power of BIM, it has not been readily adopted by industry, and especially not at the community and campus scale. Digital Campus Innovation (DCI) is a large multi-year and multidisciplinary project involving development of a methodology for use of BIM for operation and maintenance of a portion of Carleton University's 45 interconnected buildings. Major elements include: (1) development of highly-detailed BIM models for site and buildings; (2) conversion from BIM models to building performance simulation (BPS) models; (3) model validation using measured data; (4) building Fault Detection and Diagnostics (FDD) using advanced algorithms and calibrated modelling; and (5) advanced building performance data visualization on top of 3D BIM model. This paper will describe the methodologies that are being developed while demonstrating the ongoing processes by a case study of Canal Building, a part of DCI project. While the project is only one year old, impactful examples have already demonstrated BIM as an invaluable technology that improves indoor environment quality, reduces energy costs, and has a potential application for asset management.

Notes

Poster Session and Student Colloquium

Abstract

Convergence of Linear Algebraic Reliability Simulation

Seth Henry, Christopher Griffin and Paul Bruhn

Summary

In this paper, numerical methods for the solution of a reliability modeling problem are presented by finding the steady state solution of a Markov chain. The reliability modeling problem analyzed is that of a large system made up of two smaller systems each with a varying number of subsystems within them. The focus of this study is on the optimal choice and formulation of algorithm for the steady-state solution of the generator matrix for the Markov chain associated with the given reliability modeling problem. In particular, iterative linear equation solution algorithms were analyzed. The Conjugate-Gradient method was determined to have the quickest convergence with the Gauss-Seidel method following close behind. Current work associated with this project analyzes the convergence of the Successive Over-Relaxation method. This work is part of a larger program for simulating, processing, and analyzing stochastic processes associated with simulation of naval systems.

Iterative Simulation-Optimization of a Multi-State Manufacturing System

Mohammad Dehghanimohammadabadi and Thomas Keyser

Summary

Simulation optimization is an emerging field which is widely applied in various industries including manufacturing, supply chain management, risk management, and healthcare. By leaping computer advances, integration of the simulation-optimization methods has seen remarkable advances. In this study, an Iterative Optimization Simulation (IOS) approach is utilized to solve a scheduling problem with batch processing machines in order to optimize cycle time, WIP, system reliability and throughput. In this method, optimization occurs frequently at the model's operational level in order to optimize the combination of system state variables during the simulation run while the trade-off between simulation and optimization can occur either in periodic schemes or event-driven basis.

Modeling Interoperability between a Reflex and Reasoning System in a Physical Simulation Environment

Konner Atkin, John Licato and Selmer Bringsjord

Summary

When modeling the behavior of a cognitive agent in either a simulation or a real-world robotics scenario, often a choice must be made between two types of processes: An explicit, typically slow, and deliberative mode of reasoning; and a quick, automatic reflex system. This roughly corresponds to several well-known distinctions in the cognitive-psychology literature: System 1 vs. System 2, Explicit vs. Implicit, etc. However, the interaction between these processes is not typically explored in computational simulations. We present PAGI World, an open-sourced simulation environment which can represent both types of processes, and discuss how the higher-level reasoning processes can interact with the lower-level reflexes of a cognitive agent, in such a way as to complement each other. We explain motivations for this interactivity, and describe our system for addressing it.

Energy-Efficient Structures: Visualizing Environmental Performance of Structural Building Materials

Matan Mayer

Summary

In both its theoretical and practical applications, structural design focuses for the most part on span and dimensional efficiency in load-bearing systems. While rigidity and thinness are desirable qualities in most structures, reaching these qualities may involve disproportional environmental impacts which should be taken into consideration. The production of carbon fiber, for example, requires 3300% more energy than the production of structural glulam timber and releases an average of 31 times more carbon dioxide into the atmosphere. Current structural analysis and visualization methods do not account for embodied energy or carbon emission considerations. This paper describes the development of a framework for integrating life cycle environmental impact data into the analysis and design process of common elements such as columns, beams, and trusses. Aiming to primarily aid designers, the method focuses on visualizing diverse information to allow clear decision making and enable simple weighing of structural vs. environmental tradeoffs. The method is explained in detail and its use is demonstrated on a study of load-bearing beams. Among other conclusions, findings suggest that when considering embodied environmental impacts in concert with structural performance, weight plays an increasingly important role. Additionally, the study concludes that the non-linear correlation between performance and mass may imply the existence of a feasibility threshold for environmental and structural properties.

Poster Session and Student Colloquium

Abstract

Simulation Approach to Support Sustainability of Higher Education

Anatoly Kurkovsky

Summary

We consider the paradigm of sustainability in higher education as a computational environment to analyze the numerical values of the institutional goal dynamics and the possibility to reach their rational balance. We suggest using a simulation approach to tie up the institutional goals, a set of traditional institutional internal subsystems (faculty, students, educational technology, administrative structure) and a set of external requests (labor market, government, natural environment, etc.). The set of already created or planned simulation models can be used to support the sustainability of a higher education institution within two areas: simulation models for educational/research goals and simulation models to support the logistics and management processes of the institution.

Integrating Computational Fluid Dynamics with Preliminary Architectural Design for Natural Ventilation

Shan He and Ulrike Passe

Summary

Computational Fluid Dynamics (CFD) has a great potential to be integrated with preliminary architectural design for natural ventilation strategies. A wide range of natural ventilation simulations and validation research on airflow performance inside or around buildings has been published during the past years in the engineering field, but the results have not yet been integrated well into architectural design. The reason can be concluded as: 1- the complex physics and mathematics behind CFD is often not familiar to architects; 2- CFD simulation and validation are time consuming while a single CFD validation is only effective for one specific model to ensure the engineering accuracy, therefore very few generalizations are possible. With this gap, architects can rarely integrate CFD in the preliminary design process as an effective assistance. The work presented in this poster discusses what kind of design assistance CFD could provide for architects and whether the current CFD research work promises good potential for future applications.

Web-in-the-Loop Simulation Framework for Supporting CORS-Based Development

E Jin Kim and Hae Young Lee

Summary

This paper presents a simulation-based framework under development, in which a website using cross-origin resource sharing (CORS) can be developed, tested, and evaluated within synthesized websites and browsers. The framework consists of a websites simulator that produces pseudo-responses to cross-site requests and a web-clients simulator used for verification and evaluation. It could be used as stubs, or for verification and evaluation, which would lead to the alleviation of potential problems caused by the use of CORS.

Distributed Recommender System for Online Processing of Big Social Data

Lubaid Ahmed and Dr. Abdolreza Abhari

Summary

This paper presents a framework for the distributed recommender system that can process the huge amount of social data of Web 2.0 sites in online manner. To evaluate this idea a multi-agent simulator is built to exploit user profile together with information collected from user activities. For each user an agent is designed in the simulated Twitter environment that communicates with other agents to find users with similar interests and then provide recommendation to its user. This framework consists of the following tasks: building user profile using multi-agents from a social network website (i.e. Twitter), data cleansing, tweet analysis using Term Frequency / Inverse Document Frequency (TF/IDF), and providing recommendations. The first goal of the proposed distributed recommender system framework is to examine online algorithms that can be used for big social data (i.e. tweets by Twitter users) and cluster users based on their interest.

The Use of Mathematical Models for Logistics Systems Analysis (WIP)

Baiba Zvirgzdina

Summary

A mathematical model is a description of a system using mathematical concepts and language. The process of developing mathematical model is termed mathematical modelling. Mathematical models are used in logistics systems analysis. A model helps to explain a system, study the effects of different components, and make predictions about behavior. Mathematical models can take forms such as dynamical systems, statistical methodologies, differential equations, queuing theory, mathematical programming, and others. Mathematical models can be divided into two types: analytical and simulation models. Analytical models are used, when the structure of the system is relatively uncomplicated and there exists analytical form in what systems structure can be written. Most of cases simulation models are used when the systems can't be written in an analytical way. Simulation is used to study situations characterized by uncertainty. Mathematical modelling gets more and more important for logistics systems analysis as systems gets complex and there is a need for a tool that helps to understand the systems and to give the desired answers to questions in time as short as possible. There are literature sources that describe how mathematical models are applied for logistics systems analysis. Peruvemba (2005) gives a brief overview of mathematical problems in logistics. The last forty years have been very important in logistics development field, from its concentration on a company's physical processes to a holistic process and customer oriented management instrument. That also meant a continual change of the mathematical challenges in logistics (Möhring and Schenk, 2010). The importance of mathematical methods for logistics systems analysis confirms separate sections of international conferences or even ongoing individual conferences of this theme.

Result Validation Method with Small Sample or Expert Information (WIP)

Ming Yang, Xiaochao Qian and Wei Li

Summary

As simulation is a model based activities, the credibility of the model becomes an issue of great concern to the simulation user. Model validation is a major tool of credible evaluation and must be performed before the commencement of the simulation activity. Result validation is an important step of the model validation, which is usually defined as "the process of measurement the similarity between the simulation data and experimental data". However, in realistic modeling and simulation process, because of the reference system that the simulation system corresponding to is expensive to run or even does not excite, the experimental data often be the form of a small sample or expert data, intitule as reference data in this paper. A new model validation method based on evidence distance is investigated with the reference data are small sample data or expert data. Different forms of simulation and reference data are converted into evidence formats with the method of constructing a basic probability assignment. Evidence distance is proposed to measure the coherence of simulation and reference data. Several examples are given to validate the reasonableness and effectiveness of the proposed method.

Modeling Dynamic Sequences in Anylogic for the purpose of FMS Scheduling (WIP)

Dusan Sormaz and Subhabrata Ghosal

Summary

Manufacturing industry has grown in terms of technology by leaps and bounds in the past decades. However the challenge to produce most efficiently and in a cost effective manner has been a subject of research for a long time. Towards ensuring that, modern automated manufacturing came forward with the concept of flexible manufacturing system where various units of manufacturing communicate with each other in an autonomous decoupled fashion and the dynamicity of production is ensured through changing parameters at different stages. One of the most effective ways to model an FMS is agent based modeling, where each unit is designed as an independent agent capable of executing assigned tasks and communicate with each other. This paper proposes method to model the manufacturing system as a simulation model with dynamic sequences which can be loaded from external source and be modified during the simulation run. The simulation model is created for a generic FMS and it can be run to find optimized process plans and schedule for maximum performance. In the paper we report the work in progress related to creation of generic (template) simulation model in Anylogic software which can be configured from external data source with various number of resources (machines) and entities (parts) and can load part sequences from the same external data source. The model will be used to perform research and experiments with dynamic decision model regarding alternate part routings and creating dynamic sequences and scheduling in flexible manufacturing system. This model will be run with different routings (sequences) and scheduling heuristics and the results will be compared to obtain the best performance.

Abstract

Population Modeling by Examples (WIP)

Dammann, Sergey Nuzhdin, Jacob Barhak, Atesmachew Hailegiorgis, Shweta Bansal, Steve Leff, Joshua Behr, C. Anthony Hunt, Talitha Feenstra, Madhav Marathe, Mary Butler, Bradley Davidson, Paul Marjoram, Stefan Scholz, Jonathan Karnon, Aaron Garrett, Wojciech Chrosny, Samarth Swarup, Naren Ramakrishnan and Cristina Lanzas

Summary

The recent increase interest in population modeling has brought up the need to define the term. Rather than a formal definition, we are collectively defining the term by population modeling examples collected from all the authors. Examples include epidemiology, behavior, health economics, emergency response, biology, and computational tools. A formal definition is also discussed to provide a current definition for an emerging field.

Integrating a Formal Requirements Modeling Simulator and an Autonomy Software Simulator to Validate the Behavior of Unmanned Vehicles (WIP)

Elizabeth Leonard, Constance Heitmeyer and Valerie Chen

Summary

Formal requirements modeling and analysis provides a means of establishing high assurance that a system performs its functions correctly and satisfies critical properties such as safety, security, and fault tolerance. The SCR (Software Cost Reduction) requirements method has been used to successfully to specify and analyze requirements of many practical systems, including flight control and weapons systems. SCR has an associated set of tools for specification and analysis which includes a simulator that can be used in validating the behavior of requirements specifications. Currently, there are two major limitations: only discrete computation is modeled and the simulation is restricted to two-dimensional graphical displays. Both of these limitations become a problem when simulating cyber-physical systems such as unmanned vehicles. To address these limitations, this paper introduces the integration of the SCR requirements simulator with the eBotworks 3D simulator for autonomy software and illustrates the utility of the combined simulation framework by applying it to validate the requirements of an unmanned ground vehicle.

An Integrated Software Environment of Simulation Experiment Design, Analysis and Evaluation (WIP)

Wei Li, Lingyun Lu, Ping Ma, Ming Yang and Zhizhao Liu

Summary

This paper presents an integrated software environment which can aid users to design simulation experiments, monitor and control simulation process, manage and analyze simulation data, evaluate system effectiveness/ performance and simulation credibility. Many solutions are applied in this software environment for solving some problems we confronted, such as the intelligent method of simulation experiment design, flexible evaluation method of operational effectiveness, multivariate simulation result validation method and simulation optimization method based on meta-model and intelligent algorithm. The design and implementation of the software environment is described. In the end, application example of an air-defense simulation system is demonstrated how to use the software environment.

Study of Optimizing Fuel Tank Volume of Fast Combat Support Ship for Marine Operations during Wartime (WIP)

Chungman Seo and Chungwoo Lee

Summary

It is very important that the navy fulfills continuous operational missions to affect successful operations during wartime. For supporting the continuous operational missions at sea, the navy possesses fast combat support ships (US Navy hull classification symbol: AOE). As capacities of the latest battleships increase, a continuous stable supportability of an AOE to the battleships is a very prominent question. This research shows an optimal fuel tank volume of an AOE through DEVS modeling and simulation with which battleships consuming fuel and the AOE providing fuel to them are described. MS4 Me software which helps to easily create and simulate DEVS models is used to implement a virtual battle scenario, four battleships, and one AOE models for this research. The simulation result displays unavoidable waiting time to battleships at sea and the change of the waiting time with the fuel tank volume of the AOE. Besides, this research proposes that the AOE and battleship modeling and simulation is used as various analytic tools about a marine mobile logistics area with numerous battle scenarios, battleship's data, and the change of the rendezvous area between an AOE and battleships.

Work in Progress

Abstract

Synthetic Data Generation for High-Fidelity HPC Healthcare Simulation: Beneficiary-Provider Network Example (WIP)

Gautam S. Thakur, Byung H. Park, Özgür Özmen, Jack Schryver, Mallikarjun Shankar and Gilbert G. Weigand

Summary

For data-driven simulation to successfully address important questions raised in healthcare programs, it is of supreme importance to prepare accurate and realistic input data for initial conditions. In order for the model to be viable, it has to be performed at a sufficiently large scale. Hence, we can promote the understanding of the complex healthcare dynamics for an entire nation at a fine resolution. However, availability of high-resolution healthcare data is largely limited and not much work has been reported on scaling up healthcare models. This study introduces our approaches to produce realistic and high-resolution healthcare data from publicly available sources for a large-scale High Performance Computing (HPC) healthcare model that can scale to include millions of actors such as providers and beneficiaries. Additionally, we describe the conceptual model of a healthcare scenario and delineate HPC implementation of it.

Simulation of Privacy Protocols in Location-Based Service (WIP)

Hongmei chi

Summary

Location-based services greatly enrich our mobility experiences; it also comes along with privacy concerns, as a location-based service provider can now continuously track the location of a user. Although many privacy protocols have been proposed to address the privacy issues, there has not been much comprehensive study and comparison of those protocols. In this paper, the investigation is on the privacy models for location-based services via simulation. The focus of these studies is on the security issues on location-based service. The recently proposed protocols identify location-based services and compare them with well-designed benchmarks. In addition, performance analyses for each individual protocol are discussed in this paper

Approach to Reachability Analysis of Finite and Deterministic DEVS Models (WIP)

Hae Young Lee

Summary

This work-in-progress paper presents an approach to reachability analysis of a formalism for modeling and simulation, in which the transition system semantics of the formalism is defined and the transition systems corresponding to models specified by the formalism are analyzed based on the underlying technology of timed automata.

Concepts and Origins of Simulation Model Size and Complexity (WIP)

Rizwan Ahmed

Summary

Simulation model size and complexity is generally a less debated and poorly understood area. Despite the importance of model simplification and its relation with size and complexity, only a handful of papers can be found focusing on the size and complexity of a simulation model. This paper reports general concepts of simulation model size and complexity held by expert modellers and proposes a model to understand the origins of simulation model size and complexity. Size and complexity are two most important contextual factors that may affect simulation practice. Increased understanding of concepts of simulation model size and complexity held by the modellers will potentially underpin simulation methodology research and help us addressing the issues raised by increasing size and complexity of simulation models.

Work in Progress

Abstract

MitRis 1.0: DEVS Engine and DEVSML Studio (WIP)

Saurabh Mittal and Jose Luis Risco Martin

Summary

The DEVS formalism has been implemented in various platforms and languages over the years. However, each implementation has been tightly coupled with the underlying syntactical language. The DEVS Modeling Language (DEVSMML) is based on meta-modeling concepts that provide a domain-specific-language (DSL) for DEVS model description. In this paper, we introduce: MitRis 1.0 (a) a high performance DEVS engine implemented in Java, and (b) DEVSMML Eclipse Studio that implement DEVSMML execution with two DEVS engines. We elaborate on the features of MitRis modeling and simulation APIs, DEVS instrumentation and demonstrate the performance of MitRis engine with a moderately complex example of a spectroscopy system involving digital shapers.

Probabilistic Modelling of GPS-based Capabilities (WIP)

Vaughn Standley, Edward Boucheron, Robert Kirkwood and Benjamin Norman

Summary

In terms of the number of satellites in view from a ground level device or event, the global coverage provided by the GPS constellation is demonstrated to be well approximated by assuming that the satellites are randomly distributed around the earth. Analysis using GPS almanac data indicates that this is a good approximation to within about 10% accuracy. An analytic model relying on this approximation enables parametric estimation of cost, performance, and risk of GPS-based capabilities and is a means to help validate more sophisticated performance models where the average statistics representing global coverage is the dominant factor, a work in progress (WIP).

Combined Linear Regression Models (WIP)

E. L. Perry, Fortune Mhlana and Robert Kirchner

Summary

This paper presents our work towards development of predictive models of the socio-medical-economic interactions of autonomous population units (APUs). Our long-term goal is to develop APU interaction models (AIMs) that are general enough to apply to various socio-medical-economic domains. While this particular paper addresses one part of the AIM system, a simulation that incorporates many linear regression models, our overall approach combines a robust Big Data management and analytics capability with predictor / corrector methods along with this simulation to attack problems of interest.

Validation of System of Systems Emergent Behavior Through Modeling and Simulation (WIP)

Mary Ann Cummings

Summary

Today the U.S. Department of Defense acquires weapon capabilities through a System of Systems (SoS) approach. Modeling and Simulation (M&S) is believed to be an affordable validation alternative to operationally testing all functionality and interfaces in a complex weapon SoS. Emergent behavior brings uncertainty to this validation because this behavior occurs as a result of interactions of its components, and is not found in any of the components alone. This paper describes research in developing a software architecture that allows the collection and graphing of SoS metrics in one location such that these metrics can be then be used to evaluate the emergent behavior of the SoS. One way to accomplish this is to architect swappable and reusable Simulators and Experimental Frames to provide the changing of these elements without any of the other elements, including the models, having to change. We conjecture that these elements will support the collection of SoS metrics in a Metrics Collector that will interface with the Simulator and Experimental Frame. We explore whether the collected metrics will enable the identification and analysis of emergent behavior among the interactions of the models (component systems). We describe how these metrics can be collected. We also present our initial thoughts on how to effectively present the metrics to enhance the engineer's ability to reason about the system of systems' emergent behavior.

Symposium on Theory of Modeling & Simulation - DEVS (TMS/DEVS)

Dimension Reduction in Statistical Simulation of Digital Circuits

Armin Alaghi and John P. Hayes

Summary

Statistical analysis tasks are increasingly encountered in the design of digital circuits that implement complex Boolean functions. Examples include analyzing the impact of soft errors, estimating power consumption, and stochastic computation. Common simulation techniques such as quasi-Monte Carlo simulation often converge too slowly for large circuits with many inputs, i.e., many dimensions. We analyze the probabilistic properties of Boolean functions, and identify new function classes called correlation insensitive (CI) which tolerate input dependencies. Correlation insensitivity enables dimension reduction, thereby significantly improving simulation quality. We investigate the theory of CI functions and show useful links to some well-known circuit design problems.

On the Integration of HLA and FMI for Supporting Interoperability and Reusability in Distributed Simulation

Alfredo Garro and Alberto Falcone

Summary

Many research efforts are focusing on the definition of methods, models and techniques to support the reuse and interoperability of simulation models and their execution on distributed computing environments. In this context, great benefits could derive from the jointly exploitation of two popular standards: FMI (Functional Mock-up Interface) and HLA (High Level Architecture). The paper investigates how to combine HLA and FMI from two different perspectives: (i) HLA for FMI and (ii) FMI for HLA. With reference to the HLA for FMI perspective, some possible extensions to FMI to include HLA features are proposed. With respect to the FMI for HLA perspective, two concrete approaches, based on well-known design patterns, for integrating and (re)using FMUs (Functional Mock-up Unit) in HLA-based simulations are proposed. To demonstrate the effectiveness of the proposed solution, a case of study concerning a Moon base simulated scenario is also presented.

SES Extension to Integrate Abstraction Hierarchy into DEVS Modeling and Simulation

Jean-Francois Santucci, Laurent Capocchi and Bernard P. Zeigler

Summary

The modeling and simulation of complex systems often requires models described at different levels of abstraction. The System Entity Structure (SES) represents a design space via the elements of a system and their relationships in hierarchical and axiomatic manner. As it has been described in a number of publications the system entity structure supports development, pruning, and generation of a family of DEVS(Discrete Event System specification) simulation models. The goal of the paper is to propose an extension of the SES in order to integrate the concepts of abstraction hierarchy. To accomplish this task we detail the set of actions that have to be performed: 1- to formally define what is the abstraction hierarchy. 2- to add abstraction hierarchy to the SES. 3- to provide operations to implement abstraction hierarchy into DEVS modeling and simulation. The DEVS formalism allows a description hierarchy leaning on the definition of a model using a hierarchical decomposition. However, this kind of hierarchy does not involve any abstraction level definition since the behavior of the implied models is defined at a same level of abstraction. This paper deals with: (i) the formalization of the concept of abstraction hierarchy; (ii) the extension of SES in order to take into account the abstraction hierarchy; (iii) DEVS modeling and simulation of complex systems according to different levels of abstraction; (iv) the use of the DEVSimPy environment to implement both the modeling and simulation aspects involved by the abstraction management. A pedagogical example is given to illustrate the proposed approach.

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Levelized Compiled Code Multi-delay Logic Simulation

Peter Maurer

Summary

Many people feel that levelized compiled code (LCC) simulation, an oblivious simulation technique, is the fastest form of logic simulation. LCC simulation uses the zero-delay model in which gates are treated as pure functions with no internal delay. Levelized Compiled Code simulators have also been developed for the unit-delay model, in which all gates are assumed to have the same delay. When the unit-delay LCC simulators were first developed in the early '90s there was also some interest in developing an LCC multi-delay simulator, which would permit gates to have different integer delays. However, there were several factors that made multi-delay LCC simulation virtually impossible. The output of a gate may change several times during the simulation of a single input and simulation code must be generated for each such potential change. For multi-delay simulation, this yields a huge amount of generated code. For one test circuit, the generated code was 50 megabytes and required several days to compile. At the time, computer memory sizes were something on the order of 4-8 megabytes, making it impossible to execute the compiled code. Even so, it is unlikely that circuit designers would be willing to wait several days for the simulation code to compile. The generated code was essentially all straight-line code. Few if any, caches of the early '90s were prepagging which strongly favors small tight loops. Even if it were possible to execute the generated code, it would have been too slow to compete with event-driven methods. But today 50 megabytes of code is nothing, and the compilation now takes about two minutes. Virtually all caches are prepagging, negating the advantage of small tight loops. It is time to take a second look at multi-delay LCC simulation. We show that LCC multi-delay simulation can have significant advantages over event driven simulation.

FMI-Based Distributed Multi-Simulation with DACCOSIM

Virginie Galtier, Stephane Vialle, Cherifa Dad, Jean-Philippe Tavella, Jean-Philippe Lam-Yee-Mui and Gilles Plessis

Summary

Our research project aims at enabling multi-simulation based on the FMI standard and the cooperation of multiple FMUs (FMI simulation units). Our solution, DACCOSIM (Distributed Architecture for Controlled Co-Simulation), is currently assessed on an industrial use case and aims to simulate Smart Grids, but it is designed to be generic. In order to support large scale multi-simulations, DACCOSIM executes on multi-core distributed architectures. To achieve good simulation accuracy without sacrificing efficiency, we support variable step size and rollback as commonly done by continuous time simulators. The induced necessary error control is achieved thanks to existing numerical algorithms and through a hierarchical and distributed control architecture. At each step, simulation data communications also occur, but directly between FMU pairs in a fully decentralized fashion. Moreover, DACCOSIM implements an algorithm to perform the complex initialization of the various components of the multi-simulation. DACCOSIM comes as a graphical framework to easily design a multi-simulation and to automatically generate associated code, and as a library to execute it. The library relies on either JavaFMI (for the Java version) or the QTronic SDK (for the C++ version) to interface FMUs, and is multithreaded to take advantage of multi-core computing nodes. Finally, we entrust the rich 0MQ middleware to efficiently handle communications on distributed architectures. We evaluated DACCOSIM on an industrial use case provided by EDF (leading French utility company) modelling heat transfers through a building envelope. We run this use case on multi-core PCs and PC clusters. All simulation results were identical to the reference monolithic Dymola ones. Preliminary performance measurements on a 4-physical-core PC exhibit a speedup compared to monothreaded Dymola execution using the same FMUs. On multi-core PC clusters some overhead communication times appear, but larger co-simulations can be supported.

Instrumentation and Preservation of Extra-Functional Properties of Simulink Models

Joachim Denil, Hany Kashif, Pansy Arafa, Hans Vangheluwe and Sebastian Fischmeister

Summary

Tracing is a well-known technique for the debugging and optimization of software systems. Instrumentation of an application (at the source code or binary levels) enables the collection of traces for such purposes. With the advent of more complex systems, model-based design and model-driven engineering are used more often to design and implement software systems. In such model-driven approaches, a semantic gap exists between the application development at the model level and the instrumentation process at the source code/binary level. We believe that the instrumentation of applications in the modeling phase is the bridge to this gap. In this paper, we propose a solution for the instrumentation of models by allowing developers to specify their instrumentation intents at the modeling level. The proposed technique takes into account extra-functional properties, such as worst-case execution time, which are necessary for embedded and real-time systems. Developers supply instrumentation intents as well as constraints on the instrumented application based on the target architectural model. The proposed instrumentation technique searches for a feasible placement of the instrumentation blocks while satisfying extra-functional constraints. Explicit rule-based model transformation techniques realize these steps. We demonstrate the applicability of our approach using an adaptive controller case study.

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Model Transformations for Round-Trip Engineering in Control Deployment Co-Design

Ken Vanherpen, Joachim Denil, Hans Vangheluwe and Paul De Meulenaere

Summary

When developing a control algorithm for a mechatronic system, its deployment on hardware is rarely taken into account. Hardware properties such as execution performance, memory consumption, communication delays, buffer sizes, (un)reliability of the communication channel, etc. are often not the first concern of the control engineer. However, these properties may have important effects on the control loop behaviour such that initial requirements may no longer be fulfilled. To tackle this issue, we propose a Round-Trip Engineering (RTE) method allowing for a semi-automatic integration of hardware properties, corresponding to the deployment, into the control model. The proposed RTE method combines techniques of model transformations and model-based design space exploration. The resulting method will enable an engineer to further enhance the control model based on implementation properties such that the initial requirements are still satisfied when deployed on the target hardware platform.

Simulating Information Diffusion in a Multidimensional Social Network Using the DEVS Formalism (WIP)

Youssef Bouanan, Mathilde Forestier, Judicael Ribault, Gregory Zacharewicz, Bruno Vallespir and Nejib Moalla

Summary

The impact of information on individuals within a social network is, mostly, statically modeled and the dynamic is not frequently tackled. In addition, the work of modeling and simulation of the population's reactions to the information do not use explicit specification languages to describe their models. These models are specified in the shape of graph or math formulas and then directly implemented and coded using classical programming languages. We propose to model the actions of influence in a multidimensional social network (MSN). Each graph layer corresponds to a predetermined social network based on one relationship. In this work, the use of the DEVS formalism has permitted to explicit M&S of human behavior and the interaction between individuals as a network. In more detail, we define a set of models of individuals characterized by a set of state variables (e.g., using Maslow's theory to construct the behavior of an individual) and the mesh between the individuals within a social network. Then, we introduce the platform architecture, sharing resources, specifically designed to simulate MSN. In the end, a scenario is used to validate our models using the platform based on DEVS Specification.

Model-based Testing Approach for MATLAB/Simulink using System Entity Structure and Experimental Frames

Artur Schmidt, Umut Durak, Christoph Rasch and Thorsten Pawletta

Summary

In modeling and simulation, Validation and Verification (V&V) have always attracted significant interest. With Model Based Development (MBD) testing models became a part of product V&V. Model-Based Testing (MBT) is an advanced approach for automating the testing process for flexibility and adaptability. MBT advocates utilization of models for the specification of test cases and proposes workflows for automatic test case generation. The paper presents a pragmatic MBT approach for MATLAB/Simulink based on the concept of Experimental Frame (EF) and the System Entity Structure (SES). Each test case is represented following the formal structure of EF. For generating an executable EF, configurable basic models are provided by a Model Base (MB). The SES ontology is then used for the specification of test case designs on an abstract level. It describes a set of various test case structures, parameter settings and objectives. Based on the SES and MB, a specific executable test case, or a test suite, can be automatically generated for a Model Under Test (MUT). Finally, an application, using MATLAB/Simulink, is presented to exemplify the proposed approach.

A Comparative Study of Pending Event Set Implementations for PDEVS Simulation

Romain Franceschini, Paul-Antoine Bisgambiglia and Paul Antoine Bisgambiglia

Summary

The choice of a particular event-list implementation can dramatically improve or reduce performance of a discrete event simulation (DES). For more than 40 years, several data structures had been proposed to address this problem. We present new empirical results using the discrete event system specification (PDEVS) formalism and a DEVStone benchmark. Similar analyzes were previously conducted, the last one being published in 2007. This paper includes most recent proposals, particularly the LadderQueue, evaluated using the DEVS-Ruby simulator.

Symposium on Theory of Modeling & Simulation - DEVS (TMS/DEVS)

Combining DEVS with Multi-agent Concepts to Design and Simulate Multi-models of Complex Systems (WIP)

Benjamin Camus, Christine Bourjot and Vincent Chevrier

Summary

We are interested in the multi-modeling and simulation of complex systems, that is representing a complex system as a set of interacting models and simulating it with a co-simulation approach. Representing and simulating the multi-model of a complex system requires to integrate heterogeneity at several levels (representations, formalisms, simulation software, models' interactions). In this article, we present our approach that consists of combining the DEVS formalism and multi-agent concepts in order to achieve these requirements. The use of the DEVS formalism enables a rigorous integration of models described with heterogeneous formalisms and a rigorous simulation protocol. Multi-agent concepts ease the description of multi-perspective integration and the reuse of existing heterogeneous simulators. We detail the combination of both in the AA4MM approach and illustrate its use in a proof of concept.

PythonPDEVS: A distributed Parallel DEVS simulator

Yentl Van Tendeloo and Hans Vangheluwe

Summary

We extend PythonPDEVS, our modular simulator for the Parallel DEVS formalism, with parallel and distributed simulation, using optimistic synchronization based on Time Warp. Modularity is maintained, with the addition of several new components useful for distributed simulation. The PythonPDEVS simulator supports, among others, model migration, modular allocation strategies, and distributed termination conditions. Python's introspection capabilities are used to provide default state saving and message copying. Domain-specific hints, encoded in a PythonPDEVS model, are exploited by the simulator to improve performance.

Explicit Semantic Adaptation of Hybrid Formalisms for FMI Co-simulation

Joachim Denil, Bart Meyers, Bart Pussig, Paul De Meulenaere and Hans Vangheluwe

Summary

With the advent of Software-Intensive and Cyber-Physical Systems, hybrid formalisms can be used to intuitively model the interactions of different models in different formalisms. Hybrid formalisms combine discrete (time/event) model constructs with continuous-time model constructs. These hybrid formalisms usually require a dedicated simulator. In this work we explicitly model the interfaces involved in the semantic adaptation of different formalisms and implement the execution using the Functional-Mockup Interface standard for co-simulation. The interfaces and co-simulation units are automatically generated using transformations. This allows tool builders to reuse the existing simulation tools without the need to create a new simulation kernel for the hybrid formalism. We apply our approach to the modelling and (co-) simulation of an automotive power window.

Explicit Modelling of a Parallel DEVS Experimentation Environment

Simon Van Mierlo, Yentl Van Tendeloo, Sadaf Mustafiz, Bruno Barroca and Hans Vangheluwe

Summary

In this paper, we explicitly model an interactive debugging and experimentation environment for the simulation of Parallel DEVS models. We take inspiration from the code debugging world, as well as from the simulation world (including different notions of time) to model our environment. We support both as-fast-as-possible and (scaled) real-time execution of the model. To achieve this, the PythonPDEVS simulator is de/re-constructed: the environment, as well as the modal part of the simulator/debugger, are modelled using the Statecharts formalism. These models are combined, resulting in a model of the timed, reactive behaviour of a debugger for Parallel DEVS, which is used to regenerate the code of the simulator. It is then combined with a modelling and simulation environment to visually model, simulate, and debug Parallel DEVS models.

Asynchronous ODE Solvers based on Error Estimation

Fernando Barros

Summary

The efficient integration of systems of ODEs requires the use of adaptive step size able to adjust the computational effort while keeping some desired level of numerical accuracy. Traditional methods use synchronous solvers, where the most demanding equation imposes its time step to all others ODEs. More efficient methods can be developed if one can support asynchronous solvers enabling each ODE to be run with its own step size. In this paper we present the new (A)synchronous (E)rror-Based (C)ontrol step-size solver (AEC), that supports variable and independent step-size ODE integration. The new method is mainly asynchronous, being step size and synchronization controlled by error estimation information. A comparison between AEC and quantized-based solvers is presented.

Symposium on Theory of Modeling & Simulation - DEVS (TMS/DEVS)

A Modular Representation of Fluid Stochastic Petri Nets

Fernando Barros

Summary

In this paper we develop a modular representation of Fluid Stochastic Petri Nets (FSPNs) using the Hybrid Flow Systems Specification (HFSS, a formalism that combines the concepts of sampling and discrete events to describe hybrid systems. We show that HFSS provides a sound representation of FSPNs supporting a direct mapping between FSPNs elements and HFSS components. FSPNs can be modeled by a composition of HFSS components preserving the structure of the original FSPNs, removing the need for a model transformation layer to simulate FSPNs, or making it easy to develop such a mapping mechanism. We show that the continuous flow representation used by HFSS enables an efficient simulation of FSPNs. Simulation results are presented for a simple manufacturing system with machines subjected to breakdowns.

Activity Diagrams for DEVS Models: A Case Study Modeling Health Care Behavior (WIP)

Özgür Özmen and James Nutaro

Summary

Discrete Event Systems Specification (DEVS) is a widely used formalism for modeling and simulation of discrete and continuous systems. While DEVS provides a sound mathematical representation of discrete systems, its practical use of can suffer when models become complex. Five main functions, which construct the core of atomic modules in DEVS, can realize the behaviors that modelers want to represent. The integration of these functions is handled by the simulation routine, however modelers can implement each function in various ways. Therefore, there is a need for graphical representations of complex models to simplify their implementation and facilitate the their reproduction. In this work, we illustrate the use of activity diagrams for this purpose in the context of a health care behavior model, which is developed with an agent-based modeling paradigm.

A Method for Quantified Confidence of DEVS Validation

Megan Olsen and Mohammad Raunak

Summary

The Discrete Event System Specification (DEVS) framework provides a formal approach for defining a conceptual model that represents a source system. To use the model in analyzing that system, it must be validated. Generally DEVS models are validated in terms of behavior and structure, utilizing the experimental frame. Although there has been discussion on approaches to build valid DEVS models, and techniques for validating the model, we currently cannot quantify our confidence in the model's validity. We propose a technique to quantify our confidence in the validity of DEVS models. This metric can be utilized to discuss the level of validity of a model, and compare competing models. Our metric continues the DEVS trend of making modeling and simulation more formal, and increasing standardization of the modeling and simulation process.

Promoting Good Modeling Practice with a Domain-Specific Language and Statistical Algorithms designed for Parallel Computing (WIP)

Benoit Bayol, Yuting Chen, Charlotte Baey, Gautier Viaud and Paul-Henry Cournede

Summary

In this paper we present a platform that mixes a domain-specific language for stochastic discrete dynamical models implemented with LLVM and a C++ multi-threaded library for the simulation, analysis and statistical evaluation of these models. More precisely, the user can easily implement a dynamic model, specifying the state and exogenous variables, parameters, state and observation functions, noises, and then run simple simulations, sensitivity analysis, parameter estimation, data assimilation or uncertainty analysis on computation clusters. We believe that this platform can foster good modeling practices since it simplifies the management of data, models and simulations on clusters and it demonstrates the different steps for a proper model design and evaluation. This platform was initially developed for the plant growth modeling community, for which such methodological tools are deeply needed, since a large variety of models coexist in the literature with generally an absence of benchmarking between the different approaches and insufficient model evaluation. However, the software can be used in any scientific field for which discrete dynamical models are developed.

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Improving the Flexibility of Simulation Modeling with Aspects **Priyasree Bhowmik, Nathaniel Osgood and Christopher Dutchyn**

Summary

While simulation and modeling serve as increasingly popular tools in addressing complex policy challenges, modeling projects are often encumbered by significant complexity within the model itself. This includes complexity extending from software engineering challenges, implementation, management of the model execution, difficulty in maintaining metadata to cross-link models, scenario results, associated simulation results, and a dependence of knowledge-users on modelers to modify model output and visualization mechanisms to explore patterns of interest. Furthermore, debugging of and developing confidence in a model often requires enabling/disabling tracing output of various model quantities. We present techniques to enhance flexibility, transparency, usefulness and effectiveness of simulation modeling by using Aspect-Oriented Programming to automatically manage the high-level execution results (Run Log) and, separately, low-level details (Trace Log) associated with model executions. With an eye towards enabling scenario reproducibility, Run Log documents the scenarios run for a given model, and records the associated model version, scenario assumptions and elements of output. The Aspect framework for Trace Log eliminates boilerplate logging code within models, supports flexibly enabling/disabling logging, improves the robustness of the model by providing easy mechanisms of debugging, and supports knowledge-users in exploring model output. We describe the framework, experiments conducted, and feedback received.

DEVS Distributed Parallel Architecture for Enterprise Simulation **Robert Kewley, Joe McDonnell, Alex MacCalman and Carl Hein**

Summary

Model based systems engineering allows engineers to manage complexity with graphical models. Efforts within the U.S. Department of Defense to date have been successful in linking the systems architecture to a suite of executable component and cost models. This is effective in analyzing component performance. However, it is also possible to integrate these component models in a distributed simulation architecture, capturing internal interactions in order to directly analyze system-level performance. Most simulations poorly expose their data and sub-models to external interfaces. Their overhead significantly complicates integration. This paper proposes integration by casting off the simulation execution machinery of the component simulations and simply integrating their internal models as Discrete Event Systems Specification (DEVS) models. An execution engine enables integration of models in different languages via message-based distributed and parallel execution of the simulation across a network. Computing technologies to include the actor model of computation, reactive systems, and time-warp parallel discrete event simulation enable this approach. Initial development and testing has been done for a soldier-level situation awareness model.

Sequential PDEVS Architecture **Damian Vicino, Daniella Niyonkuru, Gabriel Wainer and Olivier Dalle**

Summary

Parallel DEVS (PDEVS) is a well known formalism used to describe models that can be simulated exploiting parallelism. For several years models in this formalism have been described and studied creating a large repository of modeling knowledge. PDEVS formalism provides a set of abstract algorithms defining the execution of the models. In the past several architectures where proposed to implement this abstract algorithms, being the most common cases the use of event handlers or message passing interfaces. In some context, as critical systems, the operating system doesn't provide lightweight parallelism mechanisms as threads or it is hard to prove deadlines will be covered when using them. Alternative methods, as fork, introduce more overhead to the execution while making harder proving cover execution deadlines because they introduce higher execution unpredictability. In an attempt to reuse previously studied models in this kind of systems, we defined a new architecture having a single thread of execution carrying messages in a call/return fashion to simplify execution study. In this paper we describe this proposed architecture, we delineate some implementation details of our current implementation in C++ and we compare benchmarks against other PDEVS simulator's implementations currently available.

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A Model-based Trace Testing Approach for Validation of Formal Co-simulation Models Adisak Intana, Michael Poppleton and Geoff Merrett

Summary

This paper presents a model-based trace testing (MBTT) approach to strengthen verification and validation techniques for formal co-simulation based wireless sensor network development (FoCoSim-WSN). This framework enables the functionality and protocol algorithms to be encoded in the controller model in the formal Event-B language. Use of proof tools can guarantee safety properties of this formal model. Also, network reliability and performance analysis is performed by MiXiM simulation including e.g. the network load distribution and the network latency. However, this framework lacks focus in validation coverage since test scenarios for the controller model are generated randomly from the simulation environment. Consequently, the MBTT technique is applied to validate the formal Event-B controller in co-models. This technique enables us to create test scenarios from the sequence of events in our co-simulation master algorithm. We use event trace diagrams, fault injection and recovery testing to specify functional, failing and recovery test scenarios. We define MiXiM co-simulation runs to generate long running test scenarios meeting our test requirements. The result shows how failing test scenarios in these runs (“killer traces”) enable model debugging in terms of absent or erroneous constraints and events.

What’s the Best Possible Speedup Achievable in Distributed Simulation: Amdahl’s Law Reconstructed

Bernard P. Zeigler, James J. Nutaro and Chungman Seo

Summary

Amdahl asserted that a program can run no faster than inversely related to the number of processors compared to what it can on a single processor. This speed up relation was originally stated as an assumption and has never been proved as such. For discrete event simulation, this implies that a distributed simulation is similarly limited in speed. In this paper, we derive a proof based on first principles specifically in the context of distributed simulation. The formulation and proof are simple yielding new insights into distributed simulation dependence on factors such as event work load distribution, numbers of processors, and inter-processor communication. We conclude with an interpretation of the theory to parallel DEVS simulation and show that on the average the standard DEVS distributed protocol may require at most 70% more run time of the best possible method conservative or optimistic method. Moreover, the DEVS protocol converges to the best possible speedup for models with moderate to high coupling. We conclude with a discussion of open research issues this approach raises.

Towards A Probabilistic Interpretation of Validity for Simulation Models James Nutaro and Bernard Zeigler

Summary

We propose an approach to addressing questions about the validity of a simulation model and we develop this approach in detail with respect to two specific objectives. The first objective is to decide when a successful test conducted on a model of a system justifies increased confidence in the system. The second objective is to decide when a model may be replaced by another model such that successful tests on the replacement increase our confidence in the system. The basis of our approach is a probabilistic interpretation of validation and we give specific definitions in terms of the response function of the system and its models. Within this approach, we derive conditions under which confidence in a model justifies it as a surrogate in testing and in similar conditions under which a model may be replaced by another.

Generation of an Optimised Master Algorithm for FMI Co-simulation Bert Van Acker, Joachim Denil, Hans Vangheluwe and Paul De Meulenaere

Summary

Model-based Systems Engineering plays a pivotal role in the design of Software-Intensive and Cyber-Physical Systems by enabling early virtual integration of the different parts of the system. Often multiple formalisms are combined to express the behavior of these complex engineered systems. Co-simulation in general and the Functional Mock-up Interface specifically, is a technique to simulate multiple heterogeneous models in concert. However, usage and performance of the overall co-simulation does not only depend on the accuracy of the distinct heterogeneous models. It also depends on the co-simulation master: the orchestration mechanism for this simultaneous simulation. In this paper we report on a technique to increase the performance of co-simulation. We explicitly model a co-simulation setup, using language engineering techniques. An explicit model of the co-simulation allows to automatically generate an optimal orchestration algorithm compliant to the Functional Mock-up Interface standard.

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A Model-driven Framework for Distributed Simulation of Autonomous Systems

Paolo Bocciarelli, Andrea D'Ambrogio, Andrea Giglio and Emiliano Paglia

Summary

The adoption of systems with autonomous capabilities, such as UAVs (Unmanned Aerial Vehicles), is becoming more and more relevant in many real-world operational scenarios where risky operations have to be carried out (e.g., a military battlefield or a search-and-rescue operation). In this context, innovative approaches should be introduced at design time to ensure that the system will achieve the mission objectives at operation time. To this purpose, simulation-based techniques have proven to be effective for analyzing the system behavior from the early stages of the development process. Specifically, distributed simulation techniques have shown to be essential to deal with the inherent complexity of the environment to be simulated, which generally includes several interacting entities. A distributed simulation is built by integrating into a so called federation the several simulation components (i.e., the federates) that replicate the distributed and heterogeneous structure of the relevant system. Unfortunately, currently available distributed simulation standards, such as HLA (High Level Architecture), require a non-negligible effort and significant skills in terms of both simulation methodologies and related implementation technologies. In this respect, this paper introduces an architectural framework to ease the development of distributed simulation systems. More specifically, this work focuses on the simulation-based analysis of systems with autonomous capabilities and introduces a model-driven approach to support the automated generation of HLA-based distributed simulations. The approach requires as input a system model specified by use of SysML (Systems Modeling Language), the UML-based general purpose modeling language widely used in the systems engineering domain. The proposed approach is founded on the use of model transformation techniques and exploits standards and languages introduced by the Model Driven Architecture (MDA). Several model transformations are introduced to automatically map the source SysML model into an HLA-specific model of the simulation system and eventually into the Java/HLA source code. The distributed simulation execution allows system designers to carry out a timely and cost-effective simulation-based analysis of the operational system without being required to own specific distributed simulation skills.

Automatic Generation of Simulation Models for Early Stage Evaluation of Physical System Topologies

Josef Müller, Klaas Gadeyne, Mike Nicolai and Herman Van der Auweraer

Summary

Nowadays, simulation tools cannot describe architectural variability. As such, they are mostly only used during the later stages of the design, when the architecture has already been fixed. This paper demonstrates how simulation tools can still be used in the early stages of physical system design before the system architecture is fixed, by using automatic generation of simulation models. The paper classifies the approaches to automatically generate and execute simulation models according to different criteria and explains how one can choose a suitable approach given particular criteria. Additionally, it describes some best practices for using simulation tools within optimization loops.

Visual and Persistence Behavior Modeling for DEVS

Mostafa D. Fard and Hessam S. Sarjoughian

Summary

An integrated visual modeling and simulation tool called Component-based System Modeling and Simulation (CoSMoS) is extended to support behavioral specification of parallel atomic DEVS model. An approach based on Statecharts and Graphical Modeling Framework has been developed and implemented for specifying behaviors of atomic models. One or more Statecharts can be developed for any atomic model and stored in a relational database. The behavioral modeling complements atomic and coupled DEVS structural modeling where families of models with semi-automated code generated for the DEVS-Suite simulator are systematically stored and retrieve. The behavioral modeling enriches visual development of models that have DEVS-compliant specifications with modular, component-based visual representations. The visual representation of hierarchal coupled models are automatically generated or restored. An example model is employed to show the degree of details supported both in visual representation and database representation. Current and future works are briefly described.

Simulating the Impact of Blind-spots on the Frequency of Side-sweep Accidents

Gamini Bulumulle and Lotzi Bölöni

Summary

In this paper we describe a highway traffic simulator focused on the safety of lane changes. The simulator models in detail the situational awareness and behavior of the driver, including the visibility, windows, mirrors and blind spots of the vehicle, as well as the times of checking the mirrors and initiating a lane change. Using this simulator, we perform a study estimating the time to change a lane and the frequency of side-sweep accidents in various conditions such as traffic density and relative velocity of lanes. Some of the experimental results closely match the real-world observations of the National Highway Traffic Safety Administration.

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SpSIR: A Spatially-dependent Sequential Importance Resampling For High Dimensional Spatial Temporal System Simulation

Yuan Long and Xiaolin Hu

Summary

For a high dimensional spatial temporal system, data assimilation is introduced to dynamically adjust the simulation result when the model is imperfect or the parameters are imprecise. Sequential Monte Carlo (SMC) methods or particle filters (PFs) are popular data assimilation scheme. However, in a high dimensional spatial temporal system where observations and state are spatially distributed, directly applying SMC method may lead to poor prediction result or high computational cost because of the sample size. In this paper, we break a full state and observations into spatial regions and propose a new resampling algorithm: SpSIR. This algorithm exploits the spatial locality property and employs a divide and conquer strategy to reduce state dimension and data complexity. A case study in wildfire simulation demonstrates that the proposed SpSIR algorithm improves the performance of prediction even when sample size is not quite large.

Superdense Time Trajectories for DEVS Simulation Models

Hessam Sarjoughian and Savitha Sundaramoorthi

Summary

Many scientific and engineering applications generate data that are well-suited to be studied using time series charts. Two types of time series that define input, output, and state dynamics of DEVS models are piecewise constant and event charts. In this paper, time series capable of displaying both linear and superdense time segments and trajectories are conceptualized and formulated. These lend themselves for visualizing behavior of parallel atomic and coupled DEVS models. The concept of superdense time segments is realized as plug-ins as part of the Eclipse BIRT (Business Intelligence and Reporting Tool) framework. They can receive time-based alphanumeric data sets from external static and dynamic sources including the DEVS-Suite simulator. As standalone plug-ins, time series can be used to create static plots and used in BIRT reports. These plug-ins are also integrated into the DEVS-Suite simulator where each model component's behavior can be customized and dynamically plotted. Time series charts simplify and complement tabular logging of data sets for developing simulation models that exhibit zero-time transitory state transitions.

Automatic Simulation Model Generation in the Context of Micro Manufacturing

Michael Lütjen, Daniel Rippel and Michael Freitag

Summary

The planning of manufacturing and production systems requires an integrated view of manufacturing as well as logistical aspects. Missing synchronisation of orders, processes and available resources leads to inefficiencies, which has to be considered by logistic concepts. Thereby, conceptual models can help to support the planning experts by visualisation and documentation of promising production scenarios. But still conceptual models, like BPMN, EPC, etc., are not able to fulfill the requirement of an automatic simulation model generation in the field of integrated manufacturing and logistic planning. This paper analyze the application area of micro manufacturing and presents the modeling concept GRAMOSA (graphical modeling and simulation based analysis), which is an research approach for the material flow oriented modeling of complex production processes. The modeling concept and its simulation feasibility is evaluated by a use case of micro manufacturing, which represents a typical production process with specific control strategies for defect parts.

Building Partitioning Graphs in Parallel-DEVS Context for Parallel Simulations (WIP)

Christopher Herbez, Eric Ramat and Gauthier Quesnel

Summary

With the emergence of parallel computational infrastructures at low cost, reducing simulation time becomes again an issue of the research community in modeling and simulation. This paper presents a method to improve simulation time through handling the structure of the model. This operation consists in partitioning the graph models based on several criteria. In this work, we use the DEVS formalism which is a discrete event formalism with a modular and hierarchical structure of models. To improve simulation time, we use partitioning methods. We will present the partitioning method chosen to achieve this division and quantify the resulting time savings. Many tests are performed from graphs with different sizes and shapes.

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Mission Critical Publish-subscribe Performance Modeling using Linear Algebraic and Classical Methods

Michael Gardner, Cory Beard and Appie Van de Liefvoort

Summary

Modeling Service Oriented Architecture (SOA) Publish-Subscribe (Pub/Sub) message patterns using queueing models is challenging for several reasons. Most queueing models assume a work conserving approach where a pass-thru server does not create jobs. However in the Pub-Sub message pattern, a message can be duplicated at any message node along the route to be delivered to a different destinations, forming a tree type distribution. Also, most analytic performance models of large networks make simplifying assumptions for the arrival and service processes to keep the models tractable. These assumptions may affect the accuracy of the model significantly. In this work, we construct analytic and simulation performance models for Pub/Sub messaging systems. The analytic performance model which uses Linear Algebraic Queueing Theory (LAQT) is both scalable, relatively accurate, and enables interesting new research directions. Matrix-Exponential distributions are used to model general arrival and service processes (Gi/G/1). A second analytic model constructed is a variation of the classic model Queueing Network Analyzer (QNA) with customer creation for Pub/Sub. Finally, we use a simulation model both to validate the QNA and LAQT models. We test all of these models on a network of 9 nodes with up to 12 products.

Semantic Selection for Model Composition using SAMSaaS

Sixuan Wang and Gabriel Wainer

Summary

Model composition is an objective of many M&S systems. It can select from existing models and assemble new models to satisfy user requirements. Model composition has two levels: syntactic composition (focusing on the actual implementation of composition) and semantic composition (focusing on model's underlying abstractions and meanings). Even though much work has been done in the syntactic composition, the semantic composition is still in the early stage. Especially, little research has been done in the semantic selection for model composition. The major issues are: 1) it lacks meaningful description of models; 2) it lacks semantic way to get the "meanings" of the models; and 3) it lacks of the domain specific ontology just based on the models. The goal of this paper is to improve the semantic selection for model composition in order to meet user requirements and solve the above issues. To do so, we introduce a novel architecture, named Semantic Architecture for Modeling and Simulation as a Service (SAMSaaS). SAMSaaS is a layered architecture to deploy, identify, discover, compose, and invoke varied M&S resources as services in the Cloud. This paper focuses on the semantic selection of model composition in the middle layers of SAMSaaS. In SAMSaaS, we provide a model description in XML with meaningful information. We propose a data mining method by using tags to get their semantics. We propose a tag-based ontology learning approach to learn domain specific ontology for the models. Finally, we use DEVS models as examples to show the performance and possible applications using the proposed architecture.

Integrating Web-based Simulation on IT Systems with Finite Probabilistic DEVS

Summary

Discrete Event System Specification theory has been applied to diverse domain areas with specific computer languages. MS4 Me software is based on Java for DEVS Modeling and Simulation (M&S). However, it provides Meta DEVS models called DEVS Natural Language (DNL) for an atomic model and System Entity Structure (SES) for a coupled model. The Meta DEVS model capability coalesces DEVS M&S with a web server to monitor and track real users' behaviors. We introduce Web-based Simulation Systems (WSS) consisting of databases for model information and a web simulator on a web server. Atomic models used in WSS are expressed with DNL and additional information to be displayed on web pages. Coupled models are represented with SES describing their internal structures and coupling information. We show detailed implementation of a web DEVS model using DNL and XML, and how web-based simulation works with atomic, coupled, simulator and coordinator databases. As a demonstration of WSS, a health care model with Finite Probabilistic DEVS (FP-DEVS) is applied. The WSS provides a pruning web page to create instances of a SES document, and simulation result web page to display collected data.

Things to do Nearby Restaurants

Murphy's Irish Pub

Address: 713 King St, Alexandria, VA 22314

Phone: 703-548-1717

Website: <http://murphyspub.com/murphys/alexandria/>

Old World Irish Pub featuring a beautiful roaring fireplace. Serving robust Irish-American meals at fair prices. Fresh Salmon, Fish and Chips and Irish Stew are among the favorites. Live Irish Entertainment performed nightly. Murphy's has a private party room available for receptions. We also carry a late night menu that runs until 1 a.m. including burgers, salads, fish & chips and so on!

Fish Market

Address: 105 King St, Alexandria, VA 22314

Phone: 703-836-5676

Website: <http://fishmarketva.com/>

Known for its clam chowder, raw oysters, crab cakes and "Schooners" of beer, the Fish Market is a landmark in Old Town. From its unique balcony, watch the bustle of King Street and the Potomac River. Then enjoy homemade ice cream next door at Pop's. Now offering Valet Parking on Friday & Saturday nights between 5:30 p.m. and 11:00 p.m. from the corner of Lee and King Streets.

King Street Blues

Address: 112 N. Saint Asaph St, Alexandria, VA 22314

Phone: 703-836-8800

Website: <http://www.kingstreetblues.com/home.aspx>

Located in the heart of Old Town, "Comfort Food with a Southern Accent". Try ribs, smoked pork or chicken, po' boys and many salad selections! Sun.-Thur. 11:30 a.m.-10 p.m., Fri.-Sat. 11:30 a.m.-11 p.m. Bar open later.

A la Lucia

Address: 315 Madison St, Alexandria, VA 22314

Phone: 703-836-5123

Website: <http://www.alalucia.com/>

Situated on a quiet corner in north Old Town, a la Lucia has fast become one of the neighborhood's favorite spots. Consistently recognized by Washingtonian magazine as one of the area's top 100 restaurants, it specializes in southern Italian cuisine. The dishes are simple, not trendy, and flavored by little more than the wonderfully fresh ingredients. The food here stays true to a traditional Italian table. Complimenting this fabulous food is an amazing selection of wines chosen by owner Michael Nayeri.

Things to do Nearby Restaurants

Bilbo Bagbins Restaurant

Address: 208 Queen St, Alexandria, VA 22314

Phone: 703-683-0300

Website: <http://www.bilbobaggins.net/>

A cozy local gathering place with delicious food, unusual wines and beers, and friendly service. 35 wines by the glass, 10 micro-brews on tap along with over 100 bottles from around the world.

T.J. Stone's Grill House and Tap Room

Address: 608 Montgomery St, Alexandria, VA 22314

Phone: 703-548-1004

Website: <http://www.tjstones.com/>

Alexandria's own T.J. Stone's celebrates modern American cuisine. Enjoy casual dining in the comforts of our cozy restaurant and bar with wine, beer and spirits from around the country & world.

Flat Iron Steak and Saloon

Address: 808 King St, Alexandria, VA 22314

Phone: 703-229-0777

Website: <http://www.flatironkingstreet.com/>

Flat Iron Steak & Saloon is a steakhouse and bar concept on King Street. We offer reasonably priced steaks along with other American-grill style options and comfort foods. On the weekends we offer live music downstairs on Friday and Saturday along with a DJ upstairs. Pet-friendly seasonal patio dining. Late night eats - our kitchen is open 7 days a week till midnight. All football (college and professional) is shown at the bar. On weekends the kitchen is open till 1 a.m. offering a special late night menu including sandwiches and great bar food. Our happy hour here at Flat Iron is very big hit! We have happy hour from 4-7 Monday-Friday offering \$5 food, 2.50 bud light, 3.50 craft beer, \$5 margaritas, \$5 rail liquor and \$5 red and white wine.

Grille at Morrison House

Address: 116 S. Alfred St, Alexandria, VA 22314

Phone: 703-838-8000

Website: <http://www.thegrillealexandria.com/>

Beloved for its relaxed American fine dining - great food, flawless service and an upscale atmosphere. Expect wild-game fish, the finest meats & fowl and perfect produce combined with selections from our extensive wine list. Daily specials including half-price wine night, and instrumental piano music on Thursday, Friday and Saturday nights.

Things to Do

Old Town Alexandria

Website: <http://www.visitalexandriava.com/about-alexandria/old-town-alexandria/>

Old Town Alexandria is the heart of the city on the Potomac River waterfront. This beautifully preserved historic district is George Washington's adopted hometown which continues to hum with a foodie-friendly vibe loved by presidents and First Families. Fine dining connoisseurs head to the city's gourmet hubs for palate pleasing dishes or to brick-lined streets for dining al fresco. In search of stylish steals and high end clothing, fashionistas flock to the shops of the Old Town Boutique District, hailed by The Wall Street Journal for having "some of the best stores and galleries in the [DC] region."

Get up close and personal with artists at the 82 artist studios in the Torpedo Factory Art Center or tuck into cozy venues for live theater and music. Whether you're traveling by the free King Street Trolley, bike, boat or on foot, Alexandria is an easily accessible hotspot for those seeking vibrant history and culture in a thriving city.

Minutes from DC but a world away, Old Town Alexandria is conveniently located near Ronald Reagan National Airport and is serviced by the King St-Old Town Metrorail station.

Alexandria's Footsteps to the Past Tour

221 King Street, Alexandria, VA 22314

Phone: 703-683-3451

Website: <http://www.footstepstothepast.com/>

Owned by a ninth-generation Virginian, this company offers a daily 90-minute history tour from Ramsay House Visitors Center. March-Dec, (Jan-Feb by appointment only). Also offered by appointment a variety of other tours, including Civil War.

Mount Vernon by Water Cruise

Alexandria Dock: Cameron & Union Streets, Old Town Alexandria

Phone: 703-684-0580

Website: <http://www.potomacriverboatco.com/mount-vernon-cruise.php>

Cruise along the Potomac River to George and Martha Washington's home, Mount Vernon. The self-guided tour of the estate includes George Washington's tomb, an interpretive Pioneer farm, new Museum and Education Center and so much more. For more information on the Estate visit www.mountvernon.org. Offered Tuesday-Sunday, departure time from Alexandria is 10:30am and return time is 5:30pm only. Roundtrip fares (admission to Mount Vernon included) are \$42 for adults and \$22 for children ages 6-11.

Things to Do

Water Taxi to the National Mall

1 Cameron St, Alexandria, VA 22314

Phone: 703-684-0580

Website: <http://www.potomacriverboatco.com/>

The Potomac Riverboat Company offers a 30-minute direct water taxi between Old Town Alexandria and the National Mall in Washington, DC, docking at Ohio & West Basin Drive SW, just steps from the Martin Luther King, Jr. Memorial, Franklin Delano Roosevelt Memorial, the Tidal Basin and a Capital Bikeshare station. The water taxi effortlessly pairs the world-class experience of the national monuments and Smithsonian museums with Old Town's fabric of early American history as George Washington's hometown, amidst a walkable main street brimming with top restaurants and boutiques.

The water taxi will operate at select times between March 21 - November 1, 2015. See the Potomac Riverboat Co. website for exact schedule.

TICKETS: Adults: \$28 round-trip, \$14 one-way Children under 12: \$16 round-trip, \$8 one-way

Torpedo Factory Art Center

105 N. Union St, Alexandria, VA 22314

Phone: 703-838-4565

Website: <http://torpedofactory.org/>

With the world-famous Torpedo Factory Art Center as the city's visual arts hub, Alexandria is nationally recognized as one of America's Top Art Places, with a "backbone of creative culture... [that is] exceptionally successful at combining art, artists and venues for creativity and expression...to make vibrant neighborhoods." A former World War II munitions factory, this art center now houses 82 working artist studios and more than 160 visual artists, whose artwork ranges from painting to ceramics, fiber to printmaking.

Visitors wander through the center's hallways, enjoying a cup of coffee and light fare from the first floor café, Bread & Chocolate, and witness artists at work or purchase one-of-a-kind keepsakes and statement pieces to take home. At the six galleries located throughout the building, including five cooperative galleries and the Target Gallery, art enthusiasts find work by national and international artists. Also home to The Art League-a premiere art school for the public-and the Alexandria Archaeology Museum, the Torpedo Factory Art Center anchors Alexandria's bustling creative community and brings art and culture to visitors and locals alike.

Throughout the year, the center holds rotating exhibits, seasonal festivities and Second Thursday art events, oftentimes with live music and art activities.

Things to Do

Fort Ward Museum and Historic Site

4301 W. Braddock Rd, Alexandria, VA 22304

Phone: 703-746-4848

Website: <http://www.alexandriava.gov/FortWard>

Fort Ward is the best preserved of the extensive network of Union forts and batteries known as the Civil War Defenses of Washington. The museum, patterned after a Union headquarters building, houses a fine Civil War collection and exhibits. The Fort's Northwest Bastion has been completely restored. Museum open Tues.-Sat. 10 a.m.-5 p.m., Sun. noon-5 p.m.; park open daily 9 a.m.-sunset.

National Inventors Hall of Fame

600 Dulany St, Alexandria, VA 22314

Phone: 571-272-0095

Website: <http://invent.org/>

Visit the National Inventors Hall of Fame located in the United States Patent and Trademark Office and marvel at the ingenuity of mankind!

The newly renovated National Inventors Hall of Fame is on the United States Patent and Trademark Office campus in Alexandria, VA. Experience the gallery of icons illustrating each of the 500+ Inductees and their great technological achievements that helped stimulate growth for our nation and beyond. The National Inventors Hall of Fame inspires the next generation of innovators by connecting them through the story of invention. Families and groups can interact with and explore our kiosks and archives during their visit.

The Museum Store offers a unique selection of merchandise, books, gifts, and apparel related to the USPTO and the National Inventors Hall of Fame.

The National Inventors Hall of Fame and Museum is open Tuesday-Friday from 11 a.m. to 5 p.m. and Saturday from 11 a.m. to 3 p.m. Closed on Monday, Sunday and federal holidays.

George Washington Masonic Memorial

101 Callahan Dr, Alexandria, VA 22301

Phone: 703-683-2007

<http://www.gwmemorial.org/>

Patterned after a lighthouse in Alexandria, Egypt, the Memorial displays a magnificent 17-ft. bronze statue of George Washington and an outstanding collection of Washington artifacts. Open Daily 9-5; General Admission: First & Second floor: \$7. Tower Exhibits and Observation Deck: \$10. Children 12 & under are free. Tower tours, including an incredible view from the observation deck, daily at 9:30 a.m., 11a.m., 1 p.m., 2:30 p.m. & 4 p.m.

Notes

Membership Meeting Announcement

SCS Membership Meeting



Annual Membership Meeting

Tuesday, April 14, 2015

1715 pm

The meeting will be held
in the Edison B Room. Snacks and drinks
will be provided

Open to all SCS members and future
members!



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