2024 SISO SIMposium
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Accepted Abstracts

SIM24-01

Walter Cedeno (CAE USA), Steven Díaz (CAE USA) and Stanislav Ivchenko (CAE USA)

Generative AI Agents as Role Players in Modeling, Simulation, and Wargaming

Abstract

Generative AI agents have emerged as a powerful technique for simulating human behavior in interactive applications. These agents have shown to be proficient at mimicking human behavior with the ability to remember and interact with their environment. Their ability to discern patterns and relationships in the training dataset make generative AI suitable to various defense applications such as enhancing situational awareness, decision support, workflow automation, and autonomous systems. Notwithstanding the potential of generative AI agents, limited studies exist on the evaluation of different techniques such as diffusion models, transformer-based models, generative adversarial networks, and variational autoencoders, as role-playing agents (RPAs) for modeling, simulation, and wargaming training exercises. This paper focus on the evaluation of generative AI to simulate RPAs for a simple operational task that requires collaboration with an operator. The experimental setup is based on a simulation environment for training an unmanned aerial vehicle (UAV) operator with an RPA controlling the mounted camera. We evaluate all four generative AI techniques across the process to design and deploy the RPAs. The RPA training process focuses on learning how to interpret operator commands to control the camera for capturing the requested artifacts. We explore the advantages and limitations of each technique in areas like interpretability, learning complexity, realistic behavior, and stochastic nature. We conclude with a summary of the results and provide lessons learned on the use of generative AI to develop RPAs for use in modeling, simulation, and wargaming.

Keywords: Generative Artificial Intelligence, Intelligent Agents, Diffusion Models, Transformer-based Models, Generative Adversarial Networks, Variational Autoencoders, Modeling, Simulation, Wargaming

SIM24-02

Patric Stout (TNO) and Tom van den Berg (TNO)

Zero Trust in Simulation

Abstract. In recent years, the Zero Trust approach to cybersecurity has gained increasing momentum, pushing the philosophy of “never trust, always verify”, and “assume breached”. In essence, Zero Trust mandates that proof of trustworthiness cannot be derived from simply accessing an environment: it must be possible to verify to the most risk-relevant extent possible that processes and entities can be trusted continuously and according to a dynamic context.

This presentation explores Zero Trust approaches in the context of a cloud-based simulation environment. The presentation introduces basic and additional security controls (including the introduction of an Identity Provider) and shows how these can be implemented with the new HLA 4 Federate Protocol and HLA 4 Authorizer API. Several lessons learned and recommendations in using the new HLA 4 security features are provided.

Keywords: Security, Zero Trust, HLA

SIM24-03

Brian Hu (Kitware, Inc.), Jonathan Dodge (Penn State University), Abhinav Verma (Penn State University), Tanmay Ambadkar (Penn State University), Sourav Panda (Penn State University), Sujay Koujalgi (Penn State University), Aashish Chaudhary (Kitware, Inc.), Brianna Major (Kitware, Inc.) and Bryon Lewis (Kitware, Inc.)

MIXTAPE: Middleware for Interactive XAI with Tree-Based AI Performance Evaluation

Abstract. To address the future use of simulation and AI in wargaming, and the resulting need for explainable AI (XAI), we introduce the Middleware for Interactive XAI with Tree-Based AI Performance Evaluation (MIXTAPE) system. MIXTAPE will enable the use of different wargaming scenarios, AI agents, and types of explanations within a highly performant interactive visualization tool. Towards this end, we present results using the Army Research Lab (ARL) Battlespace environment, which is a 2v2 turn-based, multi-domain environment offering both capture-the-flag and annihilation type scenarios. The MIXTAPE system provides an interactive visualization interface, which enables user understanding of AI agents' actions through a visualization dashboard and decision-tree based explanations.

This tool enables multiple views and modes of interaction, facilitating round-by-round inspection of moves and drilling down into the reasoning of AI agents. We explored different AI agent designs, including Monte Carlo Tree Search (MCTS) and Deep Q-Network (DQN) agents, as well as encoding techniques that can be used with grid-based environments. We adapted the After-Action Review for AI (AAR/AI) process to the ARL Battlespace environment, guiding users on how to leverage the provided explanations to better understand the reasoning of AI agents at various levels of abstraction (i.e., the episode, decision, and explanation levels). AAR/AI provides a structured process for evaluating and providing feedback on the performance of AI models, and is easily adaptable to new wargaming scenarios or environments. Finally, we developed an unsupervised method to discover novel behavioral clusters in a historical database of ARL Battlespace games, which allowed us to also quickly mine games to identify interesting states and actions. This approach will enable data-driven, yet human-understandable explanations of the complex reasoning of AI agents. As part of future work, we present ongoing work in our exploration of more complex domains such as StarCraft II, which incorporates elements of different unit types, terrains, and tactics. We will also present on integration of our work with state-of-the-art frameworks for scalable, multi-agent reinforcement learning, including tools such as PettingZoo and RLlib.

Keywords: Explainable AI, Wargaming, Interactive Visualization, Reinforcement Learning, Neurosymbolic Reasoning, After-Action Review, Decision-Making, Middleware

SIM24-04

Frank Drop (TNO)

Service Management and Control in Federated Simulation

Abstract. NATO and Nations use simulation for various purposes, such as training, capability development, mission rehearsal and decision support in acquisition processes. Consequently, Modelling and Simulation (M&S) has become a critical capability for the alliance and its nations.

A simulation environment constructed for these purposes may consist of a mix of components. For a collective training this includes typically simulation systems, C2 systems, C2 mediation services, simulation initialisation services, gateways, simulation middleware, security devices, data recorders, and simulation control applications. These components may be deployed at different physical locations, connected via some secure wide area network connection. In addition some of these components may be deployed in a cloud infrastructure as a service. Managing an environment with such a disperse set of components is a challenging and important task.

Service Management and Control (SMC) is a collection of capabilities to coherently manage the components in a federated environment. Initial high level SMC requirements have been captured in NATO M&S Standards (AMSP-03(B)). However, more specific requirements and suitable standards for the mentioned application areas are still missing or incomplete. And at the same time, lots of technology is available in the IT domain that can serve as a potential solution for SMC.

NATO Specialist Team MSG-224 builds upon the initial standardisation efforts. With a run-time of one year (Jan 2024 – Jan 2025), the team explores SMC requirements and desired capabilities, with the purpose to identify where further standards and best practices development can take place.

This presentation provides the status of the on-going work.

Keywords: Service Management and Control, Federated Simulation, Standards

SIM24-05

Stefan Sandberg (Labatus AB) and Andreas Ekstrand (Remograph)

Automatic Generation of High Fidelity 3D Terrain for Unreal Engine

Abstract. Automatic generation of realistic terrain for import into Unreal Engine has been made possible thanks to the Cesium for Unreal plugin and its support for the OGC 3D Tiles format. So far, import of certain frequently occurring terrain features such as trees has been limited to simple representations based on a few textured polygons.

With the latest update of the Cesium for Unreal v2.7.0 plug-in, an automated pipeline can be set up which allows tools like the Remoscape from Remograph to be used to quickly generate large, highly detailed terrain databases for the Unreal Engine.

Cesium is an open-source platform for 3D geospatial visualization originally released in 2012, initially targeting the aerospace domain. The 3D Tiles format was originally developed by Cesium in 2015 and it was accepted as an OGC standard in 2019. It has quickly become a well-used format in various 3D geospatial tools.

The Cesium for Unreal plugin is a free and open-source plugin that enables support in Unreal Engine for Cesium's 3D globe and high-resolution insets using the 3D tiles format. The plugin’s new support for instanced geometry through the I3DM format as part of the 3D Tiles standard is what allows for rendering of large amounts of higher fidelity trees and other objects.

There is ongoing work to support other features like reflecting water, detailed terrain texture, illuminating street lights, light points on masts and other obstacles as well as other features applicable to geospatial visual simulation. Software developing companies like Remograph are working together with the Cesium team to improve this functionality, although it is already a proven and very useful way of 3D geospatial visualization in Unreal Engine.

This talk aims to describe a highly automated process for generating high fidelity 3D terrain into the Unreal Engine and discuss some of the new features enabled with the latest update of the Cesium for Unreal plugin, as well as identifying some features that currently are still missing.

Keywords: Automatic Terrain Generation, OGC 3D Tiles, Cesium for Unreal, Remoscape

SIM24-06

Jose Ruiz (DGA)

Simulation Management and Control: Under the Influence of the Puppeteer

Abstract. As a simulation is not the reality, some external actions is needed to make it “alive” and “under control”. These actions are performed on simulation engines (start, stop, pause…) or directly on simulated entities (magic move, logistics update…). The standards of distributed simulation (Distributed Interactive Simulation, High Level Architecture) and the associated reference data exchange models (RPR-FOM, NETN-FOM) take into account this management of simulation and provide a support to do it. The purpose of this presentation is to deliver a short overview of the existing solutions and to introduce the current activities to improve this management of distributed simulations.

Keywords: Distributed Simulation, Simulation Management, High Level Architecture, Distributed Interactive Simulation

SIM24-07

J. Mark Pullen (George Mason University C5I Center), Jeffrey Erickson (Trideum), James Ruth (Trideum) and **Curtis Blais** (MOVES Institute, Naval Postgraduate School).

Expanding M&S-Based Mission Rehearsal in CWIX

Abstract. Federated Mission Networking (FMN) is a major NATO thrust to support interoperability, focusing on use/application of multi-national systems in coalition operations. Participants recognize the potential benefits of modelling and simulation (M&S) in supporting military operations, from Mission Rehearsal to Collective Training to Decision Support. The NATO Modelling and Simulation Group (NMSG) supported the specification process for M&S-enabled capabilities in the FMN, including two standards (HLA and C2SIM) which have NATO Standardization Agreements (STANAGs). FMN management designated MSG-201 as the M&S “Syndicate” and assigned us responsibility to document the capability of M&S to meet the FMN operational requirement for Mission Rehearsal (MR). Developers and operators are employing M&S products in the current Coalition Warrior Interoperability Exercise (CWIX) to test the use of M&S in FMN. An important part of our CWIX work has been testing the standards in MR test cases. These test cases have become progressively more realistic and in 2024 have begun to include early exploration of M&S standards use in Collective Training. This paper describes how the M&S standards support MR, including evolution of the MR test cases and potential future expansion in other military activities. This is a pre-publication of an original paper scheduled for the NATO M&S Symposium 2024.

Keywords: Military Simulation, Mission Rehearsal, CWIX

SIM24-08

Andy Fawkes (Thinke Company Ltd)

NMSG Training Data Analytics & Standards Update

Abstract. This SimBrief aims to update SISO on the NMSG's training data analytics & standards work.Data generated by training simulation systems together with technologies such as AI and biometric sensors offers the potential of transforming military training through quantitative data exploitation. Such data is increasingly seen to be valuable to analyse student learning and provide feedback, support personalized adaptive learning, and to inform decisions on curriculum, hiring, resource allocation and so forth. However, currently training systems are procured with few or no training data standards specified leading to poor data management and exploitation.

Recognising this issue, the NMSG set up an Exploratory Team (MSG-ET-056) Training Data Analytics & Standards to seek views and carry out an early literature review. It was agreed that further work would be of value to NATO and the nations. The future research project has not as yet been formally approved by the NMSG but it aims to advance training data analytics and standards for NATO and member nations by establishing standardized formats for training data exchange, biometric data exchange, and training feedback. It will also create a Community of Interest for training data analytics and a comprehensive knowledge base, along with a guide to training data security, ethics, and privacy. A Cooperative Demonstration(s) of Technology (CDT) is also planned to validate these advancements.

Keywords: Training Data, Training Analytics, Simulation Standards

SIM24-09

Stefan Sandberg (Labatus AB) and Jesper Tordenlid (Combitech AB)

WARA PS, a Persistent Virtual Testbed for Autonomous Systems

Abstract. The Wallenberg AI, Autonomous Systems and Software Program (WASP) is a major Swedish national initiative for strategically motivated basic research, education and faculty recruitment. It is by far the largest individual research program in Sweden and WASP collaborates with the major universities in Sweden. Collaboration with Swedish industry and the Swedish government is also seen to be crucial to the initiative.

WARA PS (WASP Research Arena Public Safety) is a virtual testbed providing remote access to simulators and virtual agents. Also, it acts as a physical arena, performing real life tests, demonstrations, and data collections with PhD students. The main goal for the WARA PS is to promote research in collaborative heterogeneous agents and systems of systems - with the mission to keep society safe. WARA PS is open to PhD students conducting research in a variety of domains including:

- Human AI Teaming
- Collaborating Agents
- Vehicle Control
- Perception
- Cyber Security

A Core System has been developed to be domain agnostic, support easy integration, be available 24/7, be transparent and accessible, as well as offer services to support research activities and analysis. The Core Systems is based on an infrastructure based on a publish/subscribe architecture implemented using MQTT and resources such as generic unmanned surface, air, ground and underwater vehicles.

This talk aims to describe the architecture of the persistent research platform, describe some of the use cases and share some views about future capabilities.

Keywords: MQTT, Autonomous Systems, ROS, Virtual Testbed

SIM24-10

Jamieson Gump (Air Force Research Lab and Chief M&S Office (CMSO)), Jason Sutherlin (Director, CMSO SAF/SAM), Kenneth Konwin (BAH Support Contractor - OUSD(A&S)) and Peggy Gravitz (SAIC Support Contractor - DAF CMSO)

Modeling & Simulation (M&S) Standards Body of Knowledge (BoK)

Abstract. People who are either new to the world of standards supporting M&S or those who need a refresher lack a single, comprehensive guide covering the latest standards information. Discussions on the need for a Modeling & Simulation (M&S) Standards Body of Knowledge (BoK) solution has been ongoing for several years. A practical collection of standards knowledge does not exist within a one-stop digital hub to discover, assist, and unify our M&S community. Efforts are often lengthy, fragmented and ineffective as those seeking knowledge and solutions slowly reach out to numerous experts and organizations to piece together a multi-dimensional set of complex standards puzzle pieces. Benefits of the proposed Standards BoK effort include capturing valuable knowledge to assist M&S professionals across varied levels of experience identify solutions.

This presentation focuses on the purpose of the M&S Standards BoK Standing Study Group (SSG) to investigate the need for and possible standardization of a central digital hub BoK for identifying, and in some cases, accessing core resources for M&S standards and related information supporting M&S standards. These will include resources from government, industry, and academia. For new and existing M&S professionals, a professionally-curated and managed knowledge of standards and a readily available set of digital links to core and fundamental standards-related products and information is essential.

The presentation will encourage SISO and its members to join the effort as SISO members have the essential experience and expertise to conduct this investigation. The M&S Standards BoK SSG was proposed by the United States (U.S.) Department of the Air Force (DAF) Chief Modeling and Simulation Office (CMSO) and the DAF M&S Council (DAFMSC) Standards Cross Functional Team (CFT) with the goal of providing more effectively integrated M&S resources and knowledge of relevant standards for the DAF M&S Community. Although this effort is being spearheaded by DAFMSC CFT leadership, other U.S. Services, International partners and NASA participating will strengthen this effort.

Keywords: Body of Knowledge, Simulation, Standards, Study Group

SIM24-11

Andy Fawkes (Thinke Company Ltd.)

The Metaverse - Dead or Resting?

Abstract. Since the word was first published in 1992, the metaverse has experienced fluctuating levels of interest and engagement from both the public and industry. This talk, titled "The Metaverse - Dead or Resting?" aims to investigate the current state of the metaverse, evaluating whether it has faded from mainstream consciousness or is merely in a period of dormancy, awaiting renewed interest and development, particularly with respect to its supporting standards. The presentation will begin by reviewing some of the current descriptions of the metaverse and outlining its initial promise as a transformative digital environment. It will then provide a short historical overview of the metaverse's rise to prominence, driven by technological advancements and speculative investment. The discussion will address the decline in public and commercial enthusiasm, examining factors such as technological limitations, lack of overwhelming use cases, and the rapid rise of artificial intelligence (AI) as a competing focus of innovation.

Despite the apparent downturn, evidence of ongoing work within the metaverse domain will be highlighted, particularly those in the standards arena. The implications of these trends for simulation standards and the broader field of simulation will be a focal point of the presentation. The talk will consider how evolving perceptions of the metaverse might influence the development of interoperability standards and best practices within the simulation community. Additionally, potential synergies between AI and the metaverse will be explored, considering how advancements in AI could enhance metaverse experiences and applications.

In conclusion, the talk aims to build on an earlier SIMposium 2022 metaverse presentation, and provide a balanced perspective on the metaverse's status, offering insights into its potential future trajectory and its implications for simulation standards and practices. Symposium attendees should gain an understanding of the current and future landscape of the metaverse, and what it might mean for the future of virtual and physical environments.

Keywords: Metaverse, Simulation Standards, Metaverse Standards, AI, XR

SIM24-12

Edwin Munkoh-Buabeng (Clausthal University of Technology, Institute for Informatics), Siddhartha Gupta (Clausthal University of Technology, Institute for Informatics) and Umut Durak (German Aerospace Center (DLR), Institute of Flight Systems)

Exploring Scenario-Based Testing in Everything-in-the-Loop (XiL) Simulations for Autonomous Systems

Abstract. Autonomous systems, characterised by their intricate and dynamic nature, pose significant challenges for comprehensive validation. Scenario-based testing (SBT) has emerged as a promising approach to evaluate the safety and robustness of these systems by systematically exposing them to a diverse range of operational conditions. This paper delves into the potential of SBT as a rigorous validation methodology when integrated with Everything-in-the-Loop (XiL) simulations.

By leveraging XiL environments, which provide high-fidelity representations of real-world conditions, SBT can be employed to assess autonomous system behaviour under a wide spectrum of scenarios. This paper aims to systematically examine the application of SBT within XiL simulations, particularly in the context of autonomous driving. Through a comprehensive analysis, the paper seeks to elucidate the strengths and limitations of this combined approach. By scrutinising existing literature, this work will contribute to a deeper understanding of the role of SBT in enhancing the validation and verification of autonomous systems.

Ultimately, this paper endeavours to provide valuable insights into the efficacy of SBT in XiL simulations, paving the way for the development of robust and reliable autonomous systems.

Keywords: Scenario-based Testing, Everything in the Loop, Autonomous Systems

SIM24-13

Terry Cunningham (USAFE-AFAFRICA Warfare Center (UAWC))

The UAWC: Enhancing the Global Warfighter

Abstract. The USAFE-AFAFRICA Warfare Center (UAWC), formerly known as the Warrior Preparation Center (WPC), was founded by Col. Richard “Moody” Sutter at Einsiedlerhof Air Station, Germany in 1983 as a first-of-its-kind simulation center to support Battle Staff training. Throughout the next 40 years, the UAWC evolved into a multi-faceted organization consisting of six separate squadrons and two support divisions, all dedicated to enhancing the readiness of the global warfighter across the European and African theaters. The mission of the UAWC is to enhance Joint, NATO, and Partner Nation Warfighter strategic, operational, and tactical readiness through training, education, exercises, and policy.

Recent events have accelerated the need for cooperation between NATO and partner nations to develop on-demand training to enable enduring readiness. The UAWC has responded to this need by continually evolving to meet the current threat environment. It has recognized the necessity for comprehensive, distributed multinational training in a Live Virtual Constructive Synthetic Blended (LVCSB) environment. This adaptability and evolution are crucial in providing training relevant to the current force posture, thereby ensuring the success of the Global Warfighter.

In 2023, the UAWC executed over 700 various exercises and training events throughout the year, with over 500 influenced directly by Modeling and Simulation. The UAWC's commitment to quality is evident in its use of clearly defined standards and supporting documentation, which is imperative to the successful execution and integration of the multiple elements in any distributed LVCSB environment. The UAWC utilizes an adaptable, flexible, comprehensive framework with SISO standards as the baseline. This approach streamlines the integration process, eliminates unnecessary troubleshooting, and guarantees successful execution, thereby demonstrating the center's efficiency and commitment to quality.

The Integrated Test Plan (ITP) uses SISO standards to influence every cycle of the testing, integration, and execution processes at the UAWC. The Exercise Internal Testing (EIT), Exercise Verification Testing (EVT), Exercise Functional Testing (EFT), Exercise Operational Testing (EOT), and Exercise Execution Testing (EET) all combined to form the ITP, test enumerations, emissions, munitions and connectivity using SISO parameters to ensure all organizations, internal and distributed remain consistent throughout execution. The EIT, or "build phase," involves building and testing internal components before integrating them into the distributed environment. During the EVT, the functionality and connectivity of all distributed elements are verified. For the EFT, correct functionality is tested across the distributed environment. Operational functionality and relevance to current mission requirements are validated during EOT. For execution, EET is used to continue testing and monitoring all aspects of the distributed environment for the duration of the event.

The UAWC utilizes the standards developed by SISO and other organizations to conscript guidelines to simplify the complexities of multinational, multiclassification, multi-networks, and globally distributed environments. Standardizing operations across the simulated landscape by observing, documenting, and testing is essential in enhancing the capabilities to train today's Global Warfighter.

Keywords: Modeling and Simulation, Warfighter training, Distributed training, LVCSB, UAWC, WPC

SIM24-14

Bjorn Moller (Pitch Technologies) and Nicke Sievert (Pitch Technologies)

Experiences with an HLA-Based Implementation of the SISO DDCA Debriefing Standard

Abstract. Debriefing is key in training, since it confirms learning, improves performance, strengthens team coordination and ensures safety. Many training systems have built-in debriefing capabilities or rely on a shared debriefing capability. When training for more advanced missions, for example joint or combined operations, several training systems may be used. To perform collective debriefing and share lessons learned, there is a need to manage and control debriefing components from different systems.

The SISO Distributed Debriefing Control Architecture (DDCA, SISO-STD-015-2016) makes it possible to control recording and playback in heterogeneous training setups. DDCA is based on two types of applications, a Master application that sends control messages and one or more Client applications that listens to and responds to these messages. The standard is very generic and can be implemented using any network protocol or interoperability standard like DIS, HLA, or TENA.

This presentation looks at how the standard can be realized using both HLA and a non-standard protocol. A prototypical HLA Federation Object Model (FOM) for DDCA has been developed and tested. A summary of some experiments is presented, where the debrief capabilities of a COTS debrief product, a COTS game-based trainer and a proprietary system are successfully integrated using the HLA based version of DDCA.

Several observations and proposed amendments to DDCA are finally presented. Amendments include error handling and recovery, data types, session handling and more.

Keywords: Simulation, Training, Debriefing, After Action Review, AAR, DDCA, HLA

SIM24-15

- **Chris McGroarty**, Jeremiah Long, and Christopher J. Metevier, U.S. Army Combat Capabilities Development Command - Soldier Center (DEVCOM SC)
- **Anup Raval**, Mark Schlottke, and Gregory Tracy, Dynamic Animation Systems, Inc.
- Scott Gallant, Effective Applications Corporation

Automated Simulation Management for Optimal Deployment, Monitoring, and Corrections

Abstract. Simulation Environments differ widely in terms of size, scale, configuration, and distribution. These environments range from bare metal local systems to cloud-based deployments, and every possible hybrid combination therein. By nature, these systems are technically hard to configure and deploy. For each scenario, and each use case, the deployment of simulation systems requires significant effort by a team of simulation integrators. Because this process is error-prone and time consuming, many simulation environments simply reuse previously configured environments even when the technical solution is not ideal for the new scenarios and use cases.

Ideally, the choice of simulation applications, scenarios, use cases, available hardware, and other technical factors can significantly impact how systems should be deployed. How systems are deployed should consider available compute power and networking constraints given the required processing of the simulation systems, and the protocol bandwidth requirements of those systems given the scenario and use case. For example, a fully constructive large-scale scenario could operate fully in the cloud, while a small unit training use case with users stationed at local machines might require systems deployed on local machines with enough power to handle the training applications.

In this presentation, we will describe our approach to automate simulation deployment, monitor running simulation environments, and correct errors when possible. We will detail the goals of the Automated Simulation Management (ASM) research project, which attempts to dynamically generate recommendations for optimal deployment by considering various factors involved in deployment of a simulation system aligned with the dynamism of the scenario being executed. ASM will then monitor the executing simulation environment for errors and attempt to correct those errors when possible. Finally, we will highlight our early progress and next steps for the research project.