Special Issue on Artificial Intelligence and Systems Engineering

Peter Beling[1,2,6], Tyler Cody[1], Azad M. Madni[3,4, 6], Dinesh Verma[5,6]
[1]Virginia Tech National Security Institute
[2]Grado Department of Industrial and Systems Engineering, Virginia Tech
[3]Systems Architecting and Engineering Program, University of Southern California
[4]Department of Astronautics and Aerospace and Mechanical Engineering, University of Southern California
[5]School of Systems and Enterprises, Stevens Institute of Technology
[6]Systems Engineering Research Center (SERC)
beling@vt.edu, tcody@vt.edu, azad.madni@usc.edu, dinesh.verma@stevens.edu

Motivation

Artificial intelligence (AI) is enabling both the creation of new kinds of systems and new means of engineering systems. This synergy between systems engineering (SE) and AI can be expected to redefine how systems will be designed and operated in the future.

While AI is being deployed in systems today, there are few principled frameworks to guide its use in engineering design and operation. Conventional approaches in the machine learning (ML) literature view learning in isolation, and without characterization of systems context. Further, conventional ML approaches view learning as a problem-solving procedure, not as a component system or sub-system. Thus, the primary concerns of systems engineers (e.g., specification, testing, measurement, life cycle) have not been directly addressed in the AI/ML literature.

In recent years, however, AI has shown promise in addressing the long-standing challenges in the engineering design and operation of systems. These include management of large model spaces, model curation, multi-objective optimization, and representing and performing computations on large trade spaces. When coupled with digitalization and digital engineering, it is potentially possible that AI could become the primary means for performing top-down design and supporting system operation. The key challenges to AI's use in SE are in support of model-driven engineering, reasoning with formal models and ontologies as they relate to scalable reasoning procedures (e.g., neuro-symbolic methods), and introducing requisite flexibility in system architectures to assure scalability and extensibility.

Scope

This special issue seeks original papers that address the challenges in realizing SE4AI and AI4SE. Topics under consideration include: life-cycle ready AI; hybrid human/AI systems; cognitive bias in AI systems; systems approaches to AI architecting; systems theory and AI; multi-modal AI; security in AI; adversarial machine learning; trustworthy AI; AI resilience; AI risk analysis; test & evaluation of learning-based systems; automated model-building and simulation; anticipatory design; automation of digital twins; AI-enabled evidence building; AI/SE Workforce Development; model curation.

Guest Editors

Peter Beling
Virginia Tech National Security Institute
Grado Department of Industrial and Systems Engineering, Virginia Tech
beling@vt.edu

Tyler Cody
Virginia Tech National Security Institute
tcody@vt.edu

Azad M. Madni
University Professor
Northrop Grumman Foundation Fred O'Green Chair in Engineering Professor
Professor, Astronautics and Aerospace and Mechanical Engineering
Executive Director, Systems Architecting and Engineering Program
University of Southern California
azad.madni@usc.edu

Dinesh Verma
Professor, Systems Engineering
Executive Director, Systems Engineering Research Center (SERC)
School of Systems and Enterprises, Stevens Institute of Technology
dinesh.verma@stevens.edu

Anticipated Contributions

1. TBD/TBA

Timeline (to be updated in coordination with EIC)

1 Mar 2022	Publication of Call for Papers
1 June 2022	Deadline for Submission of Papers
1 Nov 2022	Final decision sent to authors
1 Dec 2022	Final manuscript deadline
1 Feb 2023	Publication

Biographies of Guest Editors

Dr. Peter A. Beling is a professor in the Grado Department of Industrial and Systems Engineering and associate director of the Intelligent Systems Laboratory at the Virginia Tech National Security Institute. Dr. Beling's research interests lie at the intersections of systems engineering and artificial intelligence (AI) and include AI adoption, reinforcement learning, transfer learning, and digital engineering. His research has found application in a variety of domains, including mission engineering, cyber resilience of cyber-physical systems, prognostics and health management, and smart manufacturing. He received his Ph.D.in operations research from the University of California at Berkeley.

Dr. Tyler Cody is an Assistant Research Professor at the Virginia Tech National Security Institute. His research interest is in developing principles and best practices for the systems engineering of machine learning and artificial intelligence. He his research has been applied to machine learning for engineering systems broadly, including hydraulic actuators, industrial compressors, rotorcraft, telecommunication systems, and computer networks. He received his Ph.D. in systems engineering from the University of Virginia in May 2021 for his work on a systems theory of transfer learning.

Dr. Azad M. Madni is a member of the National Academy of Engineering and the Northrop Grumman Foundation Fred O'Green Chair in Engineering Professor of Astronautics and Aerospace and Mechanical Engineering in University of Southern California's Viterbi School of Engineering. He is the Executive Director of USC's Systems Architecting and Engineering Program and the founding director of the Distributed Autonomy and Intelligent Systems Laboratory. He is the founder and CEO of Intelligent Systems Technology, Inc., and the Chief Systems Engineering Advisor to The Aerospace Corporation. He received his Ph.D., M.S., and B.S. degrees in Engineering from UCLA. He conducts research in transdisciplinary systems engineering, intelligent autonomous systems, and Model Based Systems Engineering. His recent awards include *2021 INCOSE/ASEE Outstanding Engineering Educator Award*, *2021 INCOSE Benefactor Award, 2021 IEEE AESS Judith A. Resnik Space Award, 2020 IEEE SMC Norbert Wiener Award, 2020 NDIA's Ferguson Award* for Excellence in Systems Engineering, *2020 IEEE-USA Entrepreneur Achievement Award, 2019 IEEE AESS Pioneer Award*, *2019 INCOSE Founders Award, 2019 AIAA/ASEE Leland Atwood Award*, *2019 ASME CIE Leadership Award, 2019 Society for Modeling and Simulation International Presidential Award, and 2011 INCOSE Pioneer Award.* He is a Life Fellow/Fellow of IEEE, INCOSE, AIAA, AAAS, SDPS, IETE, WAS, and AAIA. He is the author of *Transdisciplinary Systems Engineering: Exploiting Convergence in a Hyper-Connected World* (Springer 2018) and co-author of *Tradeoff Decisions in System Design* (Springer, 2016).

Dr. Dinesh Verma served as the Founding Dean of the School of Systems and Enterprises at Stevens Institute of Technology from 2007 through 2016. He currently serves as the Executive Director of the Systems Engineering Research Center (SERC), a US Department of Defense sponsored University Affiliated Research Center (UARC) focused on systems engineering research; along with the Acquisition Innovation Research Center (AIRC). During his twenty years at Stevens he has successfully proposed research and academic programs exceeding $175m in value. Prior to this role, he served as Technical Director at Lockheed Martin Undersea Systems, in Manassas, Virginia, in the area of adapted systems and supportability engineering.

Before joining Lockheed Martin, Verma worked as a Research Scientist at Virginia Tech and managed the University's Systems Engineering Design Laboratory. He served as an Invited Lecturer from 1995 through 2000 at the University of Exeter, United Kingdom. In addition to his publications, Verma has received three patents in the areas of life-cycle costing and fuzzy logic techniques for evaluating design concepts. Dr. Verma has authored over 100 technical papers, book reviews, technical monographs, and co- authored three textbooks: *Maintainability: A Key to Effective Serviceability and Maintenance Management* (Wiley, 1995), *Economic Decision Analysis* (Prentice Hall, 1998), *Space Systems Engineering* (McGraw Hill, 2009). He was recognized with an Honorary Doctorate Degree (*Honoris Causa*) in Technology and Design from Linnaeus University (Sweden) in January 2007; and with an Honorary Master of Engineering Degree (*Honoris Causa*) from Stevens Institute of Technology in September 2008.