

PROCEEDINGS OF SPIE

Machine Learning from Challenging Data 2026

**Panagiotis Markopoulos
George Sklivanitis
Bing Ouyang**
Editors

**27–28 April 2026
National Harbor, Maryland, United States**

Sponsored and Published by
SPIE

Volume 14030

Proceedings of SPIE 0277-786X, V. 14030

SPIE is an international society advancing an interdisciplinary approach to the science and application of light.

The papers in this volume were part of the technical conference cited on the cover and title page. Papers were selected and subject to review by the editors and conference program committee. Some conference presentations may not be available for publication. Additional papers and presentation recordings may be available online in the SPIE Digital Library at SPIDigitalLibrary.org.

The papers reflect the work and thoughts of the authors and are published herein as submitted. The publisher is not responsible for the validity of the information or for any outcomes resulting from reliance thereon.

Please use the following format to cite material from these proceedings:

Author(s), "Title of Paper," in *Machine Learning from Challenging Data 2026*, edited by Panagiotis (. Markopoulos, George Sklivanitis, Bing Ouyang, Proc. of SPIE 14030, Seven-digit Article CID Number (DD/MM/YYYY); (DOI URL).

ISSN: 0277-786X

ISSN: 1996-756X (electronic)

ISBN: 9798902320166

ISBN: 9798902320173 (electronic)

Published by

SPIE

P.O. Box 10, Bellingham, Washington 98227-0010 USA

Telephone +1 360 676 3290 (Pacific Time)

SPIE.org

Copyright © 2026 Society of Photo-Optical Instrumentation Engineers (SPIE).

Copying of material in this book for internal or personal use, or for the internal or personal use of specific clients, beyond the fair use provisions granted by the U.S. Copyright Law is authorized by SPIE subject to payment of fees. To obtain permission to use and share articles in this volume, visit Copyright Clearance Center at copyright.com. Other copying for republication, resale, advertising or promotion, or any form of systematic or multiple reproduction of any material in this book is prohibited except with permission in writing from the publisher.

Printed in the United States of America by Curran Associates, Inc., under license from SPIE.

Publication of record for individual papers is online in the SPIE Digital Library.

**SPIE. DIGITAL
LIBRARY**

SPIDigitalLibrary.org

Paper Numbering: A unique citation identifier (CID) number is assigned to each article in the Proceedings of SPIE at the time of publication. Utilization of CIDs allows articles to be fully citable as soon as they are published online, and connects the same identifier to all online and print versions of the publication. SPIE uses a seven-digit CID article numbering system structured as follows:

- The first five digits correspond to the SPIE volume number.
- The last two digits indicate publication order within the volume using a Base 36 numbering system employing both numerals and letters. These two-number sets start with 00, 01, 02, 03, 04, 05, 06, 07, 08, 09, 0A, 0B ... 0Z, followed by 10-1Z, 20-2Z, etc. The CID Number appears on each page of the manuscript.

Contents

v *Conference Committee*

ROBUST AND DATA EFFICIENT MACHINE LEARNING

- 14030 03 **RC-GNN: robust causal graph neural networks under compound sensor corruptions**
[14030-2]
- 14030 04 **An empirical study of sample utility with stable preferential pruning** [14030-3]
- 14030 05 **Byte-level generative predictions for forensics multimedia carving** [14030-5]

MULTIMODAL MACHINE LEARNING

- 14030 06 **Mars spectrometry analysis through transformer-based deep learning** [14030-7]
- 14030 07 **Activity intelligence: evaluating tool-augmented language models for maritime AIS analysis** [14030-8]
- 14030 08 **Adaptive point cloud compression for multimodal large language model tasks** [14030-46]

SCIENTIFIC AND PHYSICS-INFORMED MACHINE LEARNING

- 14030 09 **Reconfigured physics informed neural network architecture for estimating critical parameters in a class of systems with distributed measurement** [14030-9]
- 14030 0A **A complementary theoretical analysis of sf-PINN architecture** [14030-11]
- 14030 0B **Multimodal physics simulation for space launch vehicle awareness and monitoring**
[14030-42]

ENGINEERING AND AUTONOMY APPLICATIONS

- 14030 0E **Defending continual learners from adversarial attack in tactical environments** [14030-45]
- 14030 0F **Generalizable machine learning-based bistatic ranging for backscatter tag localization**
[14030-16]

- 14030 OG **Constraint-aware path planning from natural language instructions using large language models** [14030-17]
- 14030 OH **Advancing semiconductor manufacturing through machine learning** [14030-18]

IMAGING AND VISION APPLICATIONS

- 14030 OI **Quantum-based tensor contraction layers** [14030-12]
- 14030 OJ **Machine learning-based snow coverage estimation on PV panels under extreme weather conditions** [14030-20]
- 14030 OK **Source apportionment of aerosols via single particle mass spectrometry and machine learning** [14030-23]
- 14030 OL **Mamba-BTS: boundary-aware mamba segmentation for multimodal brain tumor MRI** [14030-22]

POSTER SESSION

- 14030 OM **Navigating enhanced exploration assistance (NEXA): deployment-driven edge AI for autonomous drone surveillance** [14030-24]
- 14030 ON **POKeDMD: streaming version** [14030-25]
- 14030 OO **Predictive target pursuit for autonomous UAVs using RF-DETR with depth-aware state estimation and physics-informed trajectory prediction** [14030-26]
- 14030 OP **Evaluation of scaling and deployment of machine learning sensor networks within a simulated environment to prevent elephant poaching** [14030-27]
- 14030 OQ **Saiyan: spacecraft scene representation for autonomous in-space operations** [14030-28]
- 14030 OS **AI-powered learning from complex satellite image data: integrating random forests and deep learning for crop classification and assessment** [14030-30]
- 14030 OT **Beyond energy density: multimodal learning for porosity prediction in LPBF** [14030-32]
- 14030 OU **MindNetQ: quantum-aware governance and control for distributed artificial intelligence** [14030-33]
- 14030 OV **Mapping the unseen: building a behavioral database to support faster recovery of missing vulnerable persons** [14030-34]