LEVERAGING ARTIFICIAL INTELLIGENCE CAPABILITIES FOR STATE-OF-THE-ART HELIO- AND ASTROPHYSICS RESEARCH Thomas Y. Chen[1], [1]Academy for Mathematics, Science, and Engineering (thomaschen7@acm.org)

Introduction: Machine learning modeling and artificial intelligence have become nascent data analysis tools in the fields of heliophysics and astrophysics, providing opportunities to conduct rapid evaluation of large-scale datasets. With the development of the Daniel K. Inouye Solar Telescope (DKIST) and the planned implementation of the European Solar Telescope (EST) project, there are significant opportunities to harness the latest advances in deep learning. In this abstract, we advocate for the prioritization of decadal survey white papers focused on the integration of machine learning and AI into the next decade of solar and space physics research.

Case in Point - Nancy Grace Roman Space Telescope: With high-resolution imaging and an expansive field of view, near-infrared sensitivity, precise pointing control, and high survey speed, the Nancy Grace Roman Space Telescope will enable unprecedented capabilities to address key cosmological questions [1]. To explore the expansion and structure of the universe, the telescope will provide wavefront stability of <1 nm and utilize a Wide Field Instrument comprising 18 4k × 4k near-IR detectors [2]. With the Roman mission gathering data from millions of galaxies, artificial intelligence will be a crucial asset in processing an ultra-deep field [3]. In this work, we discuss how both statistical and machine-learning-based modeling can lead to novel discovery on this front. Machine learning approaches, such as convolutional neural networks for large quantities of imagery, are particularly suited to analyzing large cosmological databases efficiently, but the explainability of the results is a potential limitation. As the data collected will be made open-access through the Mikulski Archives for Space Telescopes (MAST), the cosmological and astrophysical communities will be able to collaborate across institutions and disciplines to perform state-of-the-art analyses, improving upon developed benchmarks [4].

Paper-Writing Strategies: As the solar and space physics decadal survey approaches, writing effective white papers on the intersection between astrophysics and machine learning is key. Being inclusive of both computer scientists and data scientists as well as astrophysicists in the writing process is key, as unique synergies can be discovered by cross-collaborating across these increasingly converging disciplines. Recently developed machine learning techniques such as unsupervised category-specific mesh reconstruction (U-CMR) should be floated as potential drivers of novel discovery in solar and space physics [5]. The potential of 3-dimensional reconstruction of 2-dimensional imagery data collected from ground-based missions is a key area of future research. The white paper-writing process should consist of proposing the integration of recent advances in computer vision and deep learning, rather than simply utilizing convolutional neural networks and recurrent neural networks, which have already been harnessed to address many research questions. Thus, both the "new applications" and "new techniques" fronts should be tackled in this process.

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