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Deep learning approaches to galaxy merger identification and classification

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Galaxy mergers are fundamental to the hierarchical assembly and evolution of galaxies, often driving starburst activity and AGN fueling. Identifying mergers and their stages, such as pre- and post-coalescence, from imaging alone, especially given the vast size of modern datasets, remains extremely challenging. We develop a supervised deep learning framework using Convolutional Neural Networks (CNNs) to classify galaxies as non-mergers, pre-mergers, or post-mergers. Our training uses mock Hyper Suprime-Cam (HSC) images from the IllustrisTNG simulations (Margalef-Bentabol et al. 2024). HSC, a precursor to LSST, is ideal for developing and validating machine learning methods for future surveys. We test our model on synthetic and real HSC data to assess robustness and generalizability. This approach demonstrates the potential of simulation-driven machine learning to reveal galaxy merger histories in upcoming wide-field surveys.

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