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Estimating Photometric Redshifts with Convolutional Neural Networks and Galaxy Images: A Case Study of Resolving Biases in Deep Learning Classifiers

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Deep Learning neural networks are powerful tools to extract information from input data, and have been increasingly applied in astrophysical studies. However, without proper treatment, data-driven algorithms such as neural networks usually cannot fully capture salient information concerned for certain tasks and thus result in a biased output harmful for subsequent analyses. It is therefore essential to resolve biases due to such imperfectness. Using galaxy photometric redshift estimation as an example, we demonstrate the approaches that we exploit to tackle the two major forms of biases in the existing Deep Learning methods of photometric redshift estimation, namely redshift-dependent residuals and mode collapse. Experiments with galaxy images from the SDSS survey and the CFHT survey show that these approaches are effective and potentially useful in real astrophysical analyses. They are also meaningful in helping us understand the training of neural networks for general classification and regression problems in computer science applications.

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