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More precise distances for early-type galaxies using machine learning

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Galaxy distances measured using the Fundamental Plane have relative errors of 20-30%. Beyond a few tens of Mpc, this means that the errors in galaxy peculiar velocities are generally larger than the peculiar velocities themselves. It is therefore highly desirable to find ways to reduce the uncertainties in Fundamental Plane distance estimates. The intrinsic scatter about the Fundamental Plane has been demonstrated to be dominated by mass-to-light ratio variations associated with the age of the stellar population. For individual galaxies, however, the uncertainties in measured ages are so large that attempts to correct for this age dependence increase, rather than decrease, the scatter in the Fundamental Plane. The best that can be done is to limit samples to the oldest galaxies, which reduces the scatter at the cost of reducing the sample size. We have therefore investigated the use of machine learning combined with measurements of a wide range of galaxy properties to obtain more precise distances. Applying a relatively simple convolutional neural network to early-type galaxies in the value-added SDSS catalogue, we are able to reduce the scatter about the Fundamental Plane by a factor of 2. We identify the galaxy properties that are most important to achieving this improvement and suggest possible physical mechanisms leading to the reduced scatter. If this result translates to smaller peculiar velocity errors, and can be extended to other datasets, it will greatly increase the precision and power of the next generation of peculiar velocity surveys.

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