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## Finding Observable Environmental Measures of Halo Properties using Neural Networks

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Simulations have revealed correlations between the properties of dark matter halos and their environment, made visible by the galaxies which inherit these connections through their host halos. We define a measure of the environment based on the location and observable properties of a galaxy's nearest neighbors in order to capture the broad information content available in the environment. We then use a neural network to learn the connection between the multi-dimensional space defined by the observable properties of galaxies and the properties of their host halos using mock galaxy-catalogs from UNIVERSEMACHINE. The trained networks will: 1) reveal new connections between galaxy, halo, and environment; 2) serve as a powerful tool for placing galaxies into halos in future cosmological simulations; and 3) be a framework for inferring the properties of real halos from next-generation survey data, allowing for direct comparison between observational statistics and theory. We will first show the results of estimating the masses of halos and sub-halos. This will be followed by preliminary results on halo properties beyond mass, including satellite membership and concentration.

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