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Computational Morphometric Analysis in Astrophysics and Cosmology

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Abstract content
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We discuss the state of the art in morphometric analysis of galactic structures in astrophysical and cosmological scales. From the practical point of view, we present a hybrid many-core Mic60/K40 computational morphometric system to automatically analyze structure and pattern formation in astrophysics (e.g. galaxy classes) and cosmology (e.g. filaments, voids and "Zeldovich-pancakes"). The system includes the original and modified versions of the following coefficients: Concentration, Asymmetry, Euler Characteristic, Smoothness, Entropy and Spirality. Using a sample of spiral and elliptical galaxies from the Galaxy Zoo project as a training set, we employed the Linear Discriminant Analysis technique to classify SDSS Legacy (779,235 galaxies) samples. The cross-validation test shows that we can achieve an accuracy of more than 86\% with our classification scheme. Therefore, a plane in the morphometric parameter space can be defined which separates the elliptical and spiral classes with a mismatch between classes smaller than 10\%. The distance to different space parameters planes as a morphometric index is also useful to characterize structure formation in large-scale structure simulation as from the galactic systems simulated from Millenium and Illustris projects. A selection of quite new methodologies and applications are presented within the context of Data-Intensive Scientific Analysis related to the main data repositories available for extra-galactic astrophysics research. The main challenges in hybrid/heterogeneous computer science for those purposes are addressed.

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