

# Swarm Intelligence-based Extraction and Manifold Crawling Along the Large-Scale Structure

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The spatial distribution of matter on the mega-parsec scale of the Universe forms a complex and highly anisotropic pattern termed the Cosmic Web or the Large-Scale Structure. In the study of the Cosmic Web, several tools and methodologies have been developed to inspect the properties of its different environments i.e. clusters, filaments, walls, and voids. In this work, we show that the previously introduced framework 1-Dimensional Recovery, Extraction, and Analysis of Manifolds (1-DREAM) can analyze cosmological N-body simulation data of the Cosmic Web. 1-DREAM is a toolbox consisting of five Machine Learning algorithms that jointly serve the extraction and modelling of 1-dimensional structures in big data astronomical settings. After explaining the function of the different algorithms, we compare our toolbox with other methods which trace structures of the Cosmic Web. We show that 1-DREAM is able to split the network into its various environments with results comparable to the state-of-the-art methodologies. A comparison with the publicly available code DisPerSE demonstrates the ability of 1-DREAM to recover axes well aligned with the centers of cosmic filaments.

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