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Galaxy Morphological Classification with Manifold Learning

Thursday, 12 June 2025 15:00 (20 minutes)

We investigated classical machine learning algorithms for categorizing galaxy morphology using the Galaxy Zoo DECaLS dataset. It contains more than 300,000 photos of galaxies, from which we selected 50,000 images with the highest coincidence of human classification choice. Our methodology combined dimensionality reduction with subsequent classification. We evaluated five reduction techniques (LLE, Isomap, UMAP, t-SNE, PCA) followed by standard classifiers. Results show that preprocessing with Locally Linear Embedding (LLE) typically yielded the best performance for most classifiers, reaching accuracy levels comparable to basic neural networks. A key finding is that the 3D representation derived from LLE for shape analysis retained interpretability of reduced dimensions, a common challenge with nonlinear transformations. Additionally, applying k-means clustering in post-reduction data showed ambiguous results regarding natural data groupings; although one metric (Davies-Bouldin index) suggested four clusters aligning with astronomical human intuition, others (silhouette and elbow method, Dunn index) failed to identify a distinct structure.

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