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Testing ΛCDM cosmological model with Genetic Algorithms

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The quest to understand the cosmos has led to the remarkable discovery that the universe is expanding at an accelerating rate. This revelation necessitated the integration of dark energy into the standard cosmological model, known as ΛCDM. While ΛCDM model has achieved remarkable success in explaining various observations, it still faces challenges and uncertainties related to dark energy and dark matter. To assess its validity, researchers have employed various methodologies, including consistency checks, tests of general relativity, and model-independent approaches. In this work, we propose the use of Genetic Algorithms, a machine learning technique, to test the ΛCDM model by comparing its predictions with observational data. Specifically, we utilize genetic algorithms to analyse cosmic observables, such as the Hubble rate parameter H(z) and the growth rate of cosmological structures f(z), in order to obtain two independent reconstructions of the dark energy equation of state w(z) for testing the standard model independently of theoretical assumptions. We conduct a comparative analysis by applying genetic algorithms to real data, and examine the results obtained comparing those with the ones resulted from other machine learning techniques. We find that current data is not precise enough for robust reconstruction of the two forms of w. Then we perform extensive tests of the ΛCDM model using simulated datasets, considering future survey observations, and we find that genetic algorithms represent a strong technique to do model-independent tests based on stage IV surveys because of a resulting robust reconstruction.

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