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Diffusion-model approach to flavor models: A case study for S_4' modular flavor model

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We propose a numerical method of searching for parameters with experimental constraints in generic flavor models by utilizing diffusion models, which are classified as a type of generative artificial intelligence (generative AI). As a specific example, we consider the S_4' modular flavor model and construct a neural network that reproduces quark masses, the CKM matrix, and the Jarlskog invariant by treating free parameters in the flavor model as generating targets. By generating new parameters with the trained network, we find various phenomenologically interesting parameter regions where an analytical evaluation of the S_4' model is challenging. Additionally, we confirm that the spontaneous CP violation occurs in the S_4' model. The diffusion model enables an inverse problem approach, allowing the machine to provide a series of plausible model parameters from given experimental data. Moreover, it can serve as a versatile analytical tool for extracting new physical predictions from flavor models. References are arXiv:2503.21432 [hep-ph] and arXiv:2504.00944 [hep-ph].

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