hep-aid: A Modular Python Library for Parameter Scans in BSM Phenomenology

Within Beyond the Standard Model phenomenology (BSM), parameter scan methods must address several computational challenges, including high-dimensional parameter spaces, the computational cost of numerical evaluations, and a large number of constraints in the physical observable space. Several algorithms have been developed to address these challenges, such as, MCMC sampling methods and machine learning-based sampling strategies.

We introduce a new Python library, hep-aid, which provides a modular framework for developing parameter scan algorithms for BSM phenomenology. It manages the HEP software ecosystem and currently sup ports the SARAH family of programs. The library provides components to ease the utilisation, implementation, and development of parameter scan algorithms. This includes a general objective function constructor that handles the input and output of the HEP tools, data-set handling, plotting utilities, and parallel point evaluation.
We demonstrate the library through two examples: First, replicating results from a study of the B-L SSM [1] model. Where an Bayesian Active Search method is used to accommodate results from an observed signal at ~ 95GeV in neutral scalar searches in the $h \to \gamma\gamma$ channel. Second, implementing a Neural Network-basWithin Beyond the Standard Model phenomenology (BSM), parameter scan methods must address several computational challenges, including high-dimensional parameter spaces, the computational cost of numerical evaluations, and a large number of constraints in the physical observable space. Several algorithms have been developed to address these challenges, such as, MCMC sampling methods and machine learning-based sampling strategies.

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References

[1] Mauricio A. Diaz, Giorgio Cerro, Srinandan Dasmahapatra, and Stefano Moretti, Bayesian Active Search on Parameter Space: a 95 GeV Spin-0 Resonance in the $(B-L)$SSM, arXiv preprint, 2024. https://arxiv.org/abs/2404.18653.
[2] Jie Ren, Lei Wu, Jin Min Yang, and Jun Zhao, Exploring supersymmetry with machine learning, Nuclear Physics B, vol. 943, p. 114613, 2019. https://doi.org/10.1016/j.nuclphysb.2019.114613.

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