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Deciphering the Structure of EFTs from String Theory using JAX and Reinforcement Learning

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Applications of Machine Learning to physics beyond the Standard Model are becoming increasingly invaluable for theorists. As a leading proposal for a theory of quantum gravity, string theory gives rise to a plethora of 4-dimensional EFTs upon compactification, the so-called string landscape. For decades, a prohibiting factor in analysing these EFTs has been the computational cost of standard sampling methods in high dimensional model spaces. In this talk, we present recent progress in alleviating this problem by numerically constructing string vacua through a novel framework called JAXVacua (ArXiv:2306.06160). At its heart, it makes use of auto-differentiation and just-in-time compilation features of the python library JAX. We argue that this method grants access to previously unexplored regimes in the landscape of UV-complete EFTs. Beyond that, we describe how Reinforcement Learning (RL) can be employed to uncover organising principles underlying phenomenologically viable EFTs from string compactifications. Specifically, we use a multi-agent RL implementation known as SwarmRL (ArXiv:2307.00994) which is also built on the JAX ecosystem. We demonstrate ways in which RL exploits successful strategies for locating phenomenologically preferable EFTs, thereby revealing unknown structures in the string landscape.

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