Computing Physical Yukawa Couplings from String Theory

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We present a numerical calculation, based on machine-learning techniques, of the physical Yukawa couplings in a heterotic string theory model, obtained by compactifying on a smooth Calabi-Yau three-fold. The model in question is one of a large class of heterotic line bundle models with precisely the MSSM low-energy spectrum plus fields uncharged under the standard-model group. The relevant quantities, that is, the Ricci-flat Calabi-Yau metric, the Hermitian Yang-Mills bundle metrics and the harmonic bundle-valued forms, are all computed by training suitable neural networks. The calculation is carried out at several points along one-parameter family in complex structure moduli space, and each complete calculation takes about a day on a laptop. The methods presented here can be generalised to other string models and constructions, including to F-theory models.

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