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Learning the Simplicity of Scattering Amplitudes

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The simplification and reorganization of complex expressions lies at the core of scientific progress, particularly in theoretical high-energy physics. This work explores the application of machine learning to a particular facet of this challenge: the task of simplifying scattering amplitudes expressed in terms of spinor-helicity variables. We demonstrate that an encoder-decoder transformer architecture achieves impressive simplification capabilities for expressions composed of handfuls of terms. Lengthier expressions are implemented in an additional embedding network, trained using contrastive learning, which isolates subexpressions that are more likely to simplify. The resulting framework is capable of reducing expressions with hundreds of terms - a regular occurrence in quantum field theory calculations - to vastly simpler equivalent expressions. Starting from lengthy input expressions, our networks can generate the Parke-Taylor formula for five-point gluon scattering, as well as new compact expressions for five-point amplitudes involving scalars and gravitons.

Track

Theory

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