String theory, CAP and machine learning

Martin Bies

Institut für Theoretische Physik,
69120 Heidelberg, Germany

Abstract

The holy grail of *string theory* is to prove or disprove that a *string vacuum* furnishes a description of the physical universe that we are living in. A minimalistic check to tell if a *string vacuum* could match the experimental results from particle accelerators is to compute the *massless spectrum.* For a special class of *string vacua* – the so-called *F-theory vacua* – I will explain that this eventually leads to *cohomologies of coherent sheaves.*

The functionality of *CAP* extends far beyond *coherent sheaves.* However, the CAP-framework is perfectly suited for a modern implementation of coherent sheaves and their cohomologies. Indeed, much progress has been made on this subject during the last few years. Despite these successes, the required computations test the boundaries of these implementations in terms of computational time and power. To overcome these limitations, we are currently investigating if techniques from *machine learning* can help. I will conclude this talk with results on this work in progress.

Background on string theory

Currently, it is believe that all physical phenomena can be described by the combined action of the four *fundamental forces*: gravity, electromagnetism, weak- and strong interaction. Albert Einstein's *general relativity* furnishes the modern description of gravity and the *standard model of particle physics* describes the combined effects of the other three fundamental forces in the language of *quantum field theory.* However, a unified description of all four forces is still up for debate.

String theory provides an ultra-violet-finite quantum field theory with a massless spin-2 particle. The latter is expected to be the force carrier of quantum gravity. Therefore, this observation makes *string theory* a promising candidate for a description of quantum gravity or equivalently a unified description of the four *fundamental forces.*

One downside of *string theory* is that it predicts our universe to consist of 10 spacetime dimensions. To make contact with our everyday experience, string theorists often assume that this 10-dimensional spacetime M_{10} can be described as Cartesian product $M_{10} = M_4 \times S_6$. In this expression, M_4 is a 4-dimensional Riemannian manifold encoding the 3-spatial and the timelike dimension of our everyday experience. S_6 however, is a priori just *any* compact 6-dimensional Riemannian manifold. Upon quantisation, it is estimated that this ambiguity leads to 10^{500} to 10^{1000} solutions, each of which is called a *string vacuum.*