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Quantum gravity and Machine learning

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The best-known example of quantum gravity theory is the holographic principle (the AdS/CFT correspondence), in which a quantum gravitational geometry is equivalent to a lower dimensional non-gravitating quantum system. To find a consistent gravity counterpart starting from the latter is an important problem in quantum gravity and string theory. This is called "Bulk reconstruction,"and is a key idea revealing the mechanism of the holographic geometry. Various methods were proposed to solve this inverse problem. We use deep learning and identify the neural network as the emergent geometry, to reconstruct the bulk geometry. As the quantum data, the lattice QCD data such as chiral condensate, hadron spectra or Wilson loop is used as input data to learn and reconstruct the emergent geometry of the bulk. The requirement that the bulk geometry is a consistent solution of an Einstein-dilaton system determines the bulk gravity action backwards, to complete the reconstruction program. We demonstrate that our geometric neural networks work as a method solving quantum gravity, and the flexibility of accommodating various inverse problems in neural networks is a key in applying machine learning to physical problems.

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