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Renormalization and hierarchical knowledge representations

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Our understanding of any given complex physical system is made of not just one, but many theories which capture different aspects of the system. These theories are often stitched together only in informal ways. An exception is given by renormalization group techniques, which provide formal ways of hierarchically connecting descriptions at different scales.

In machine learning, the various layers of a deep neural network seem to represent different levels of abstraction. How does this compare to scale in renormalization? Can one build a common information-theoretic framework underlying those techniques?

To approach these questions, I compare two different renormalization techniques (which emerged from quantum information theory), and attempt to adapt them to unsupervised learning tasks. One approach, MERA, superficially resembles a deep convolutional neural net, while another approach based on dimensional reduction yields something similar to principal component analysis.

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