Dynamic Neuron Approach to Deep Neural Networks

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Deep neural network architectures often consist of repetitive structural elements. We introduce an approach that reveals these patterns and can be broadly applied to the study of deep learning. Similarly to how a power strip helps untangle and organize complex cable connections, this approach treats neurons as additional degrees of freedom in interactions, simplifying the structure and enhancing the intuitive understanding of interactions within deep neural networks. Furthermore, it reveals the translational symmetry of deep neural networks, which simplifies the application of the renormalization group transformation—a method that effectively analyzes the scaling behavior of the system. By utilizing translational symmetry and renormalization group transformations, we can analyze critical phenomena and investigate theoretical macroscopic properties of deep neural networks. We further provide empirical validation through Monte Carlo simulations. This approach may open new avenues for studying deep neural networks using statistical physics. This talk is mainly based on Phys. Rev. Research 7, 023276.