Renormalization Group

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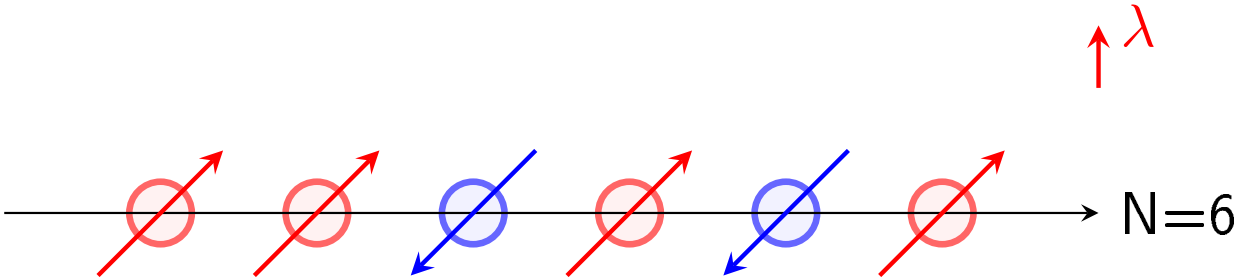
1-D Ising Model:



$$H = \lambda \sum_{i}^{N} \sigma_z^i - \sum_{i}^{N-1} \sigma_x^{i+1} \sigma_x^i$$

where

$$\sigma_z^i = \underbrace{\mathbb{I} \otimes \mathbb{I} \otimes \ldots \otimes \mathbb{I}}_{i-1} \otimes \begin{pmatrix} 1 & 0 \\ 0 & -1 \end{pmatrix} \otimes \underbrace{\mathbb{I} \otimes \ldots \otimes \mathbb{I}}_{N-i}$$

$$\sigma_x^i = \underbrace{\mathbb{I} \otimes \mathbb{I} \otimes \ldots \otimes \mathbb{I}}_{i-1} \otimes \begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix} \otimes \underbrace{\mathbb{I} \otimes \ldots \otimes \mathbb{I}}_{N-i}$$

Algorithm:

1. Initialize Ising's Hamiltonian for a given N: H_N
2. Double the system size:

$$H_{2N} = H_N^L + H_N^R + H^{INT} =$$
$$= H_N \otimes \bigotimes_{i=1}^{N} \mathbb{I} + \bigotimes_{i=1}^{N} \mathbb{I} \otimes H_N$$

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