Samples of deep learning applications in statistical and quantum physics

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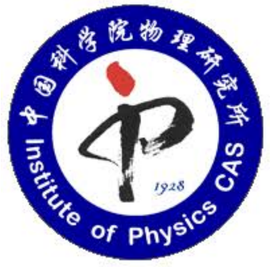
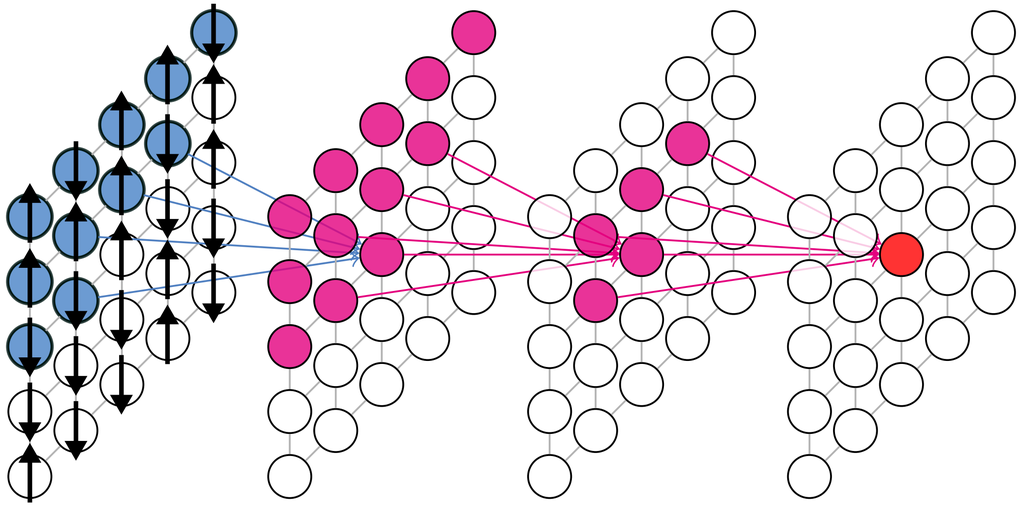


Variational autoregressive network

$$\mathscr{L} = \sum_{x} q(\boldsymbol{x})[\ln q(\boldsymbol{x}) + \beta E(\boldsymbol{x})]$$

Direct sampling, variational upper bound free energy



https://github.com/wdphy16/stat-mech-van

Quantum state
Sharir, et al ‘19

Gradient Estimators

$$\mathbb{E}_{\boldsymbol{x}\sim q_\theta(\boldsymbol{x})}[f(\boldsymbol{x})]$$

Reinforcement learning,
Variational MC,
Variational inference
…

REINFORCE

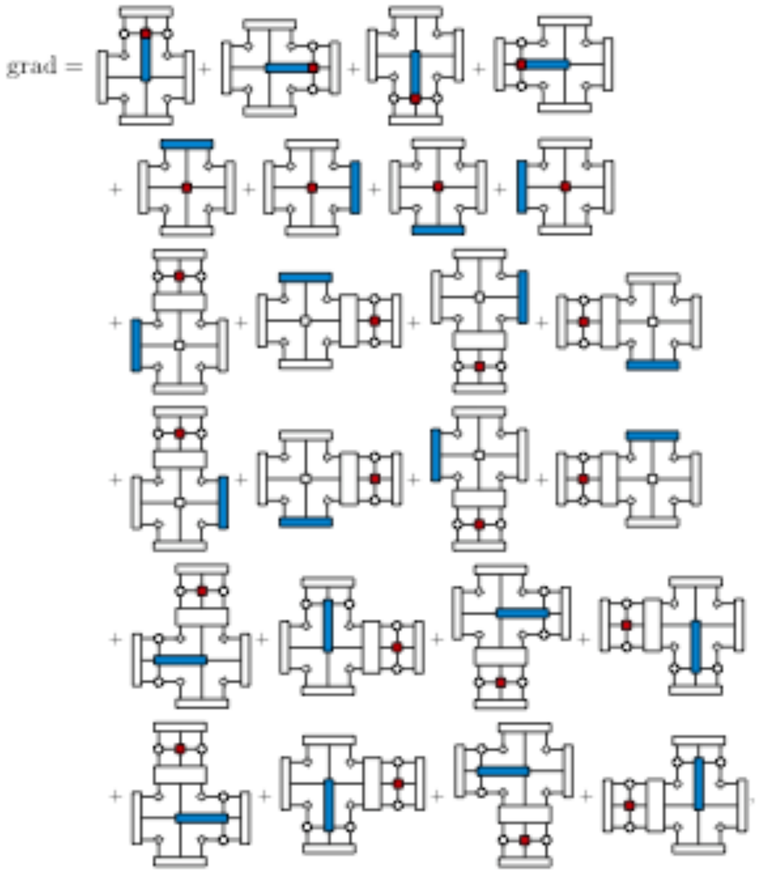
$$\nabla_\theta \mathbb{E}_{\boldsymbol{x}\sim q_\theta(\boldsymbol{x})}[f(\boldsymbol{x})] = \mathbb{E}_{\boldsymbol{x}\sim q_\theta(\boldsymbol{x})}[f(\boldsymbol{x})\nabla_\theta \ln q_\theta(\boldsymbol{x})]$$

Reparametrization Trick $\boldsymbol{x} = g_\theta(\boldsymbol{z})$

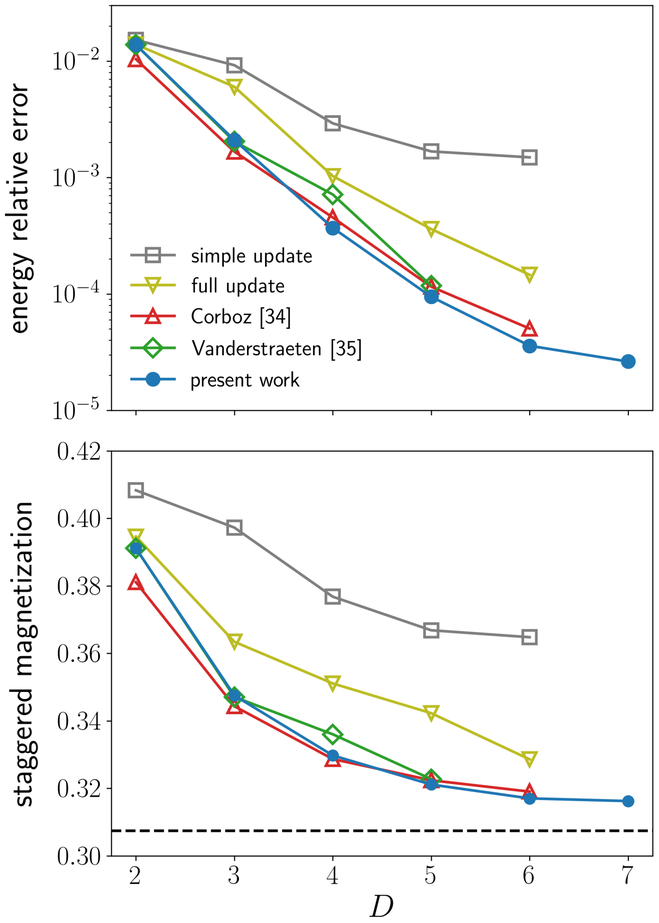
$$\nabla_\theta \mathbb{E}_{\boldsymbol{x}\sim q_\theta(\boldsymbol{x})}[f(\boldsymbol{x})] = \mathbb{E}_{\boldsymbol{z}\sim p(\boldsymbol{z})}[\nabla_\theta f(g_\theta(\boldsymbol{z}))]$$

Back to tensor networks

Hand derived gradient



AD optimized iPEPS

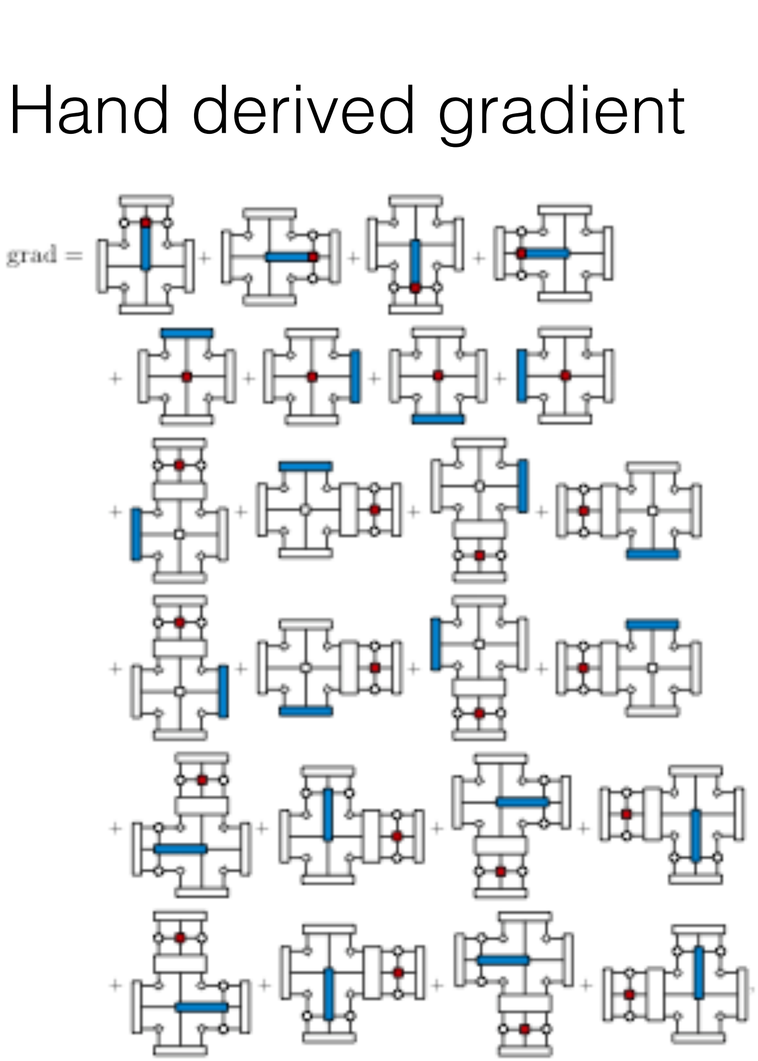


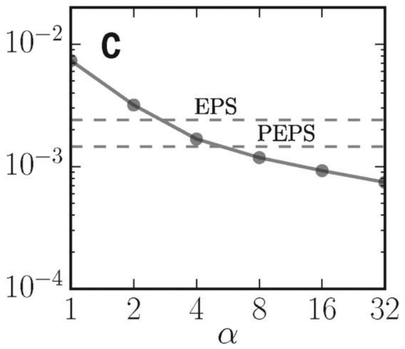
Vanderstraeten ’16, Corboz ’16

https://github.com/wangleiphy/tensorgrad

Back to tensor networks

10x10 RBM





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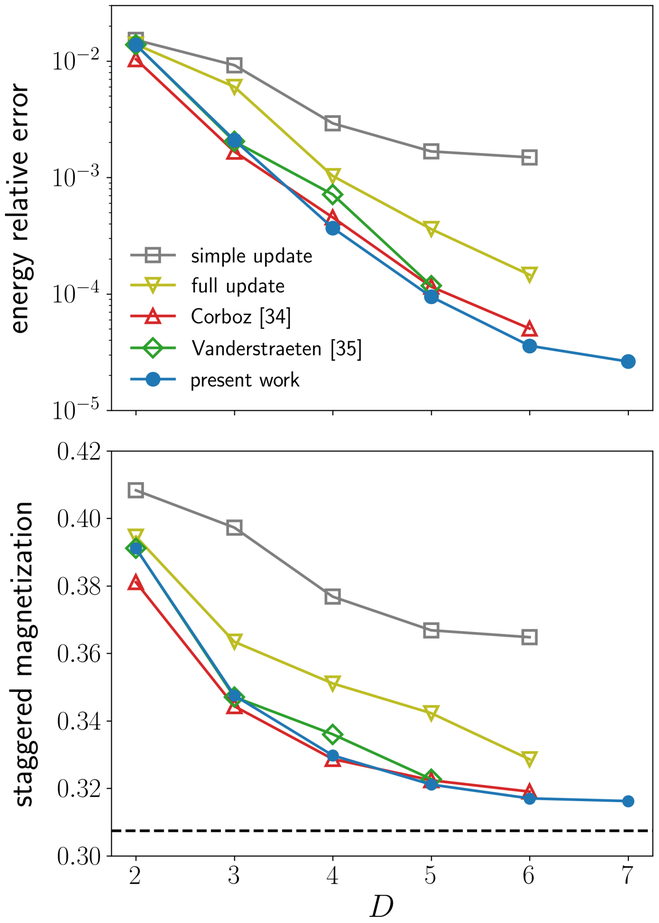

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