ML Unfolding for error reduction in Lattice QCD observables

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Poster # 77
Thu : 12-15

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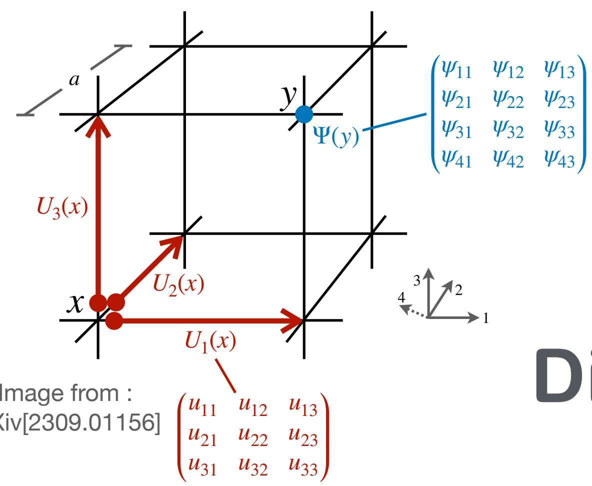


Image from : arXiv[2309.01156]

Lattice QCD - currently our best probe for understanding low energy QCD

Discretise space-time and move to Euclidean space

↓

Sample Gauge configurations from a probability distribution

↓

$$Z = \int \mathscr{D}U \det M_f^n e^{-S_G}$$

Compute observables on the generated configurations $\mathcal{O}(\sim (1-10)K)$

$$\langle \mathcal{O} \rangle \sim \frac{\partial \ln Z}{\partial K} \sim Tr\left(M_f^{-1} \frac{\partial M_f}{\partial K} \right)$$

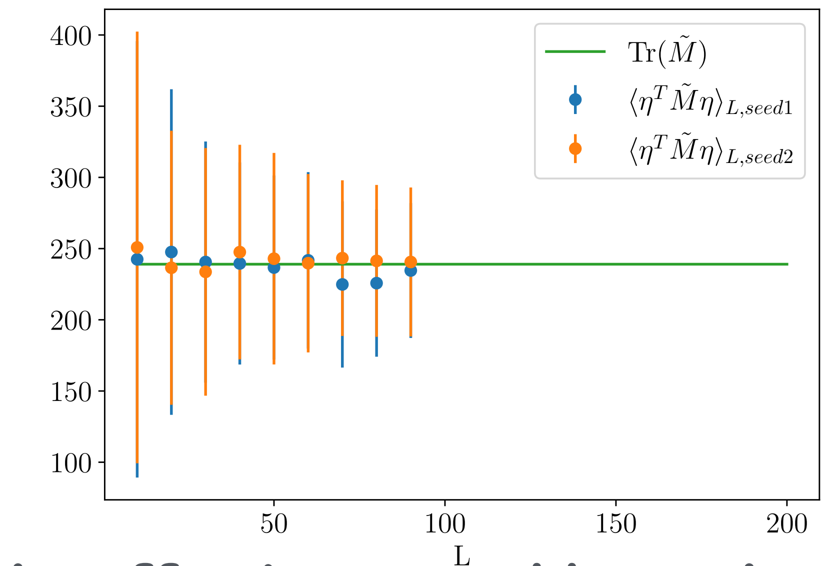
Typical size of Fermion matrices : $N_\sigma^3 \times N_\tau \times N_c \times 4$ **, can go up to** $\sim O(10^7 - 10^9)$

Random Noise Method

No access to individual matrix elements - only matrix vector products !

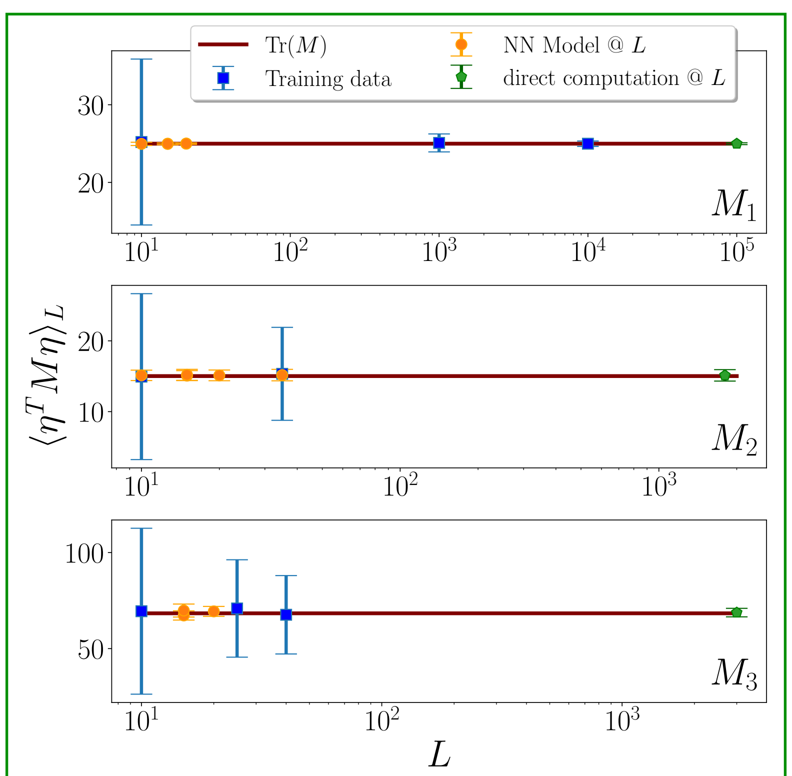
Choose **L** randomly drawn vectors η satisfying certain conditions to get

$$\langle \eta^T M \eta \rangle_L \simeq TrM + \mathcal{O}\left(\frac{f(M)}{\sqrt{L}}\right)$$



Data Unfolding via NN

Question 1 : Can we train a **NN** to learn the systematic effect caused by using only finite such random vectors - given for some observable the **true distribution** with very large L and **measured distribution** with very small L ?



Question 2 : How does this generalise to different Matrices?

Poster # 77 on Thu !