Machine Learning of Many Body Localization

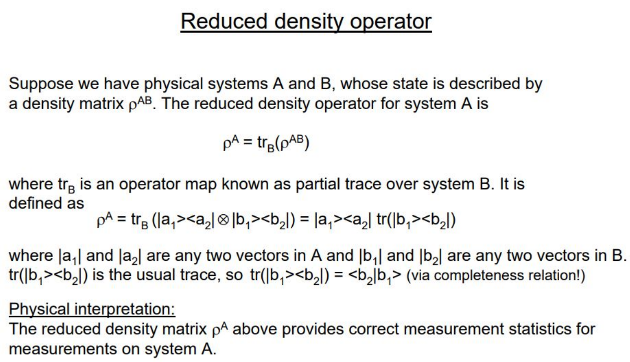
Philipp Krüger
(Dated: July 8, 2020)

A paper usually includes an abstract, a concise summary of the work covered at length in the main body of the paper. Please also write a short abstract of your project.

I. INTRODUCTION

Introduce concepts: Exact Diagonalization,

areal Density Matrix: `http://www.thphys.nuim.ie/staff/jvala/Lecture_9.pdf`



Reduced density operator

Suppose we have physical systems A and B, whose state is described by a density matrix ρ^{AB}. The reduced density operator for system A is

$$\rho^A = \mathrm{tr}_B(\rho^{AB})$$

where tr_B is an operator map known as partial trace over system B. It is defined as

$$\rho^A = \mathrm{tr}_B\,(|a_1><a_2|\otimes|b_1><b_2|) = |a_1><a_2|\ \mathrm{tr}(|b_1><b_2|)$$

where $|a_1|$ and $|a_2|$ are any two vectors in A and $|b_1|$ and $|b_2|$ are any two vectors in B. $\mathrm{tr}(|b_1><b_2|)$ is the usual trace, so $\mathrm{tr}(|b_1><b_2|) = <b_2|b_1>$ (via completeness relation!)

Physical interpretation:

The reduced density matrix ρ^A above provides correct measurement statistics for measurements on system A.

FIG. 1. Example of a figure [7].

direct density matrix: (DOI: 10.1103/PhysRevB.99.054208 says Instead of dividing the system into two subsystems A and B to calculate the reduced density matrix of an eigenstate rho a and using the entanglement spectrum as the training data set 34,35, we directly feed the probability density of the eigenstate psi i computed in the spin basis to the machines as the training data set. The reason for doing so is that, although by preprocessing the training data can reduce the dimension and filter out redundant information, useful information contained in the wavefunction of the entire system can also be lost.)

Conclusion: => areal

, Neural Network, CNN

Outcome expectation: J<g: adiabatically connected to trivial state, J>g ordered phase

Is scaling important?

Review Literature on task

II. MATERIALS AND METHODS

Explain Flow with figure

Fig. 2

Explain metrics and errors and why they are used. Which ml models are used and why?

Hyperparameters? Amount of layers?

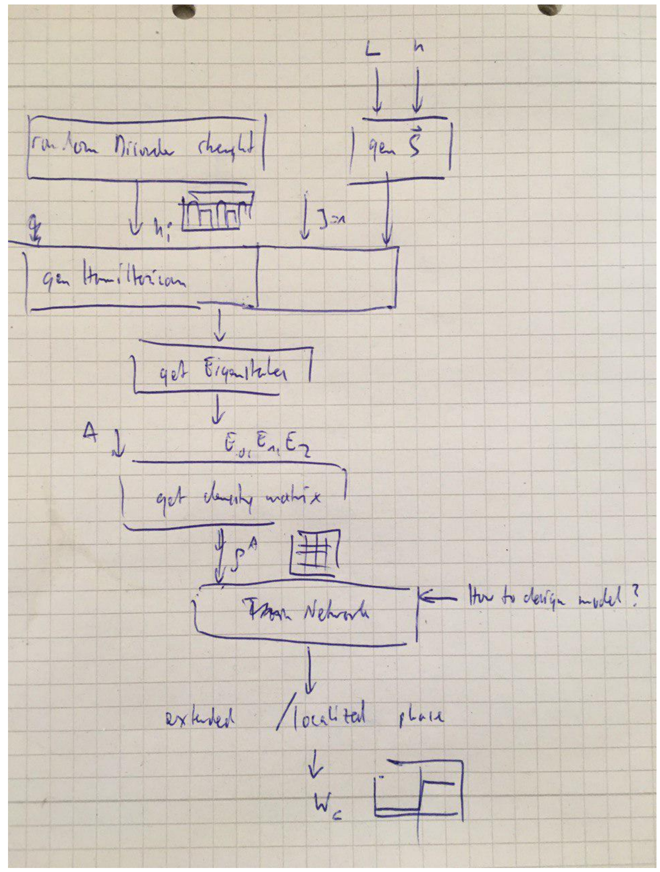


FIG. 2. Example of a figure [7].

III. RESULTS

A. Generation of density matrix training set

Plots: What is computationally realizable in 1h concerning time? The training set was sufficiently large enough

We only need M Eigenstates

This is how corresponding density matrices look like

This will be our parameter space for n, L

B. Prediction of extended vs localized phase

Training and testing scores

C. W_c analysis

Those are our W_c depending on n, L.

IV. CONCLUSION

W_c depends on n, L (yes/no).

W_c prediction coincides with the expectation (yes/no)

W_c is dependent on these and that effects => scaling analysis? (yes/no)

Citations are numerical[1], some more citations [2–6].

[1] A. Einstein, Yu. Podolsky, and N. Rosen (EPR), Phys. Rev. **47**, 777 (1935).
[2] R. P. Feynman, Phys. Rev. **94**, 262 (1954).
[3] N. D. Birell and P. C. W. Davies, *Quantum Fields in Curved Space* (Cambridge University Press, 1982).
[4] J. G. P. Berman and J. F. M. Izrailev, Stability of nonlinear modes, Physica D **88**, 445 (1983).
[5] E. Witten, (2001), hep-th/0106109.
[6] E. B. Davies and L. Parns, Trapped modes in acoustic waveguides, Q. J. Mech. Appl. Math. **51**, 477 (1988).
[7] R. Orus, A practical introduction to tensor networks: Matrix product states and projected entangled pair states, Annals of Physics **349**, 117 (2013), 1306.2164.

Appendix A: Code listing

Please copy your code in the appendix.

```
"""

Description

"""

import numpy as np

code
```