RWTH Aachen — Institut für Theorie der Statistischen Physik

Hands-on Tensor Networks WS 25/26

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Ex 1
27.10.2025

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1. Julia Install Party

If you choose to use Julia as your programming language, try to install it on your system. This will be the language presented in the exercise class.

2. SVD a matrix

Perform an SVD on the matrix A given in Moodle as A.txt and find the Schmidt rank needed if singular values below 10^{-3} are discarded.
To read in .txt files in Julia you can use:

```julia
using DelimitedFiles

A = readdlm("A.txt")
```

3. SVD a state

Perform an SVD on the state psi.jls given in Moodle (psi.npy for Python, use np.load in that case). The format is a tensor of rank 10, dimensions $2^{10} = 1024$.
Find the Schmidt rank needed if singular values below 10^{-6} are discarded for:

(a) a bipartition of the system after the first site

(b) a bipartition of the system in the middle

Help for loading the state in Julia:

```julia
using LinearAlgebra, Serialization

psi = deserialize("psi.jls")
```

4. SVD an image

Reproduce an SVD based image compression (use the image in Moodle or anything else you might like).
Hint: Perform an SVD on each color channel.

5. Contractions

Generate two random matrices A, B each of size $N \times N$ and calculate the product $C_{i,j} = A_{i,k}B_{k,j}$,

(a) once without using any libraries

(b) once using a library of your choice

for a reasonable range of N (this should still run in a reasonable amount of time) and compare the run-time of the two approaches, as well as their scaling in N (plot time vs. N and try to fit $f(N) = aN^x + b$). What do you observe?