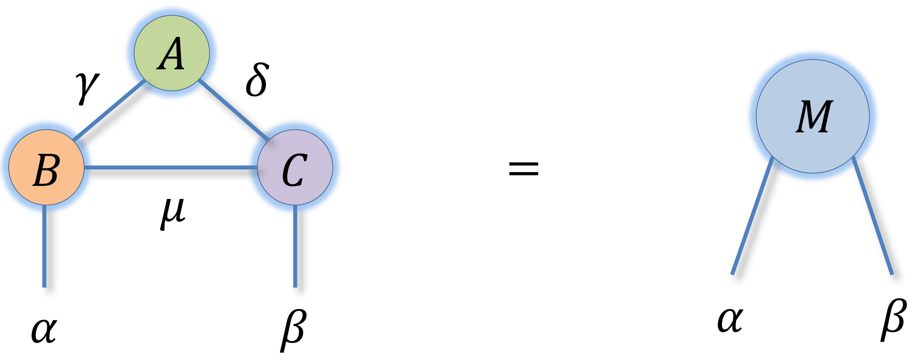
SS2021: Tensor Networks
Institut für Theoretische Physik, TU Dresden
Lecturer: Hong-Hao Tu
Tutorial: 22.04.2021

Problem Set 1

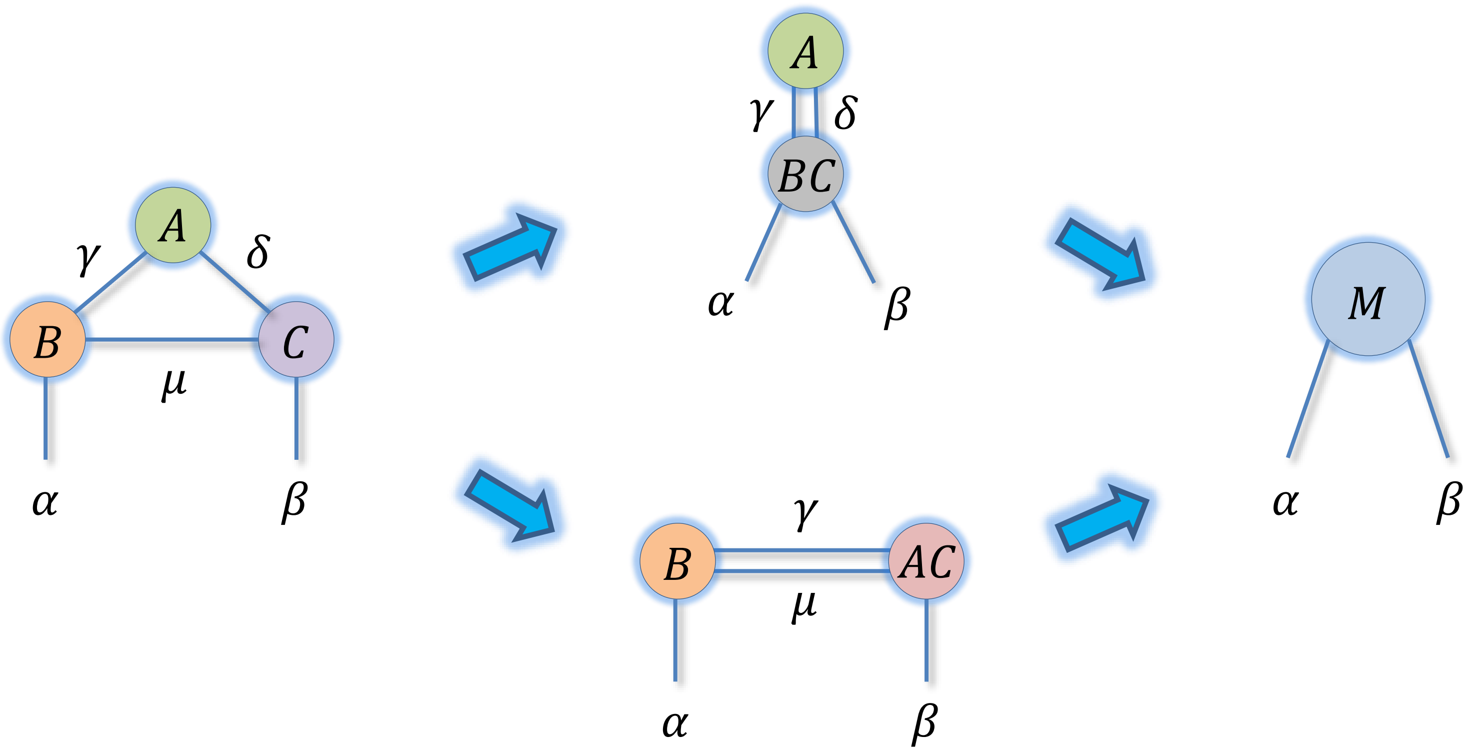
Exercise 1: Tensor contraction

- Consider the following tensor contraction problem:



SS2021: Tensor Networks
Institut für Theoretische Physik, TU Dresden
Lecturer: Hong-Hao Tu
Tutorial: 22.04.2021

- Here A, B, C are (random) tensors with bond dimension D. Which of the following two approaches has lower computational cost? Verify your result with some code.



TECHNISCHE UNIVERSITÄT DRESDEN

Exercise 2: Iterative diagonalization with MPS

- Implement the iterative diagonalization algorithm for the spin-1/2 Heisenberg chain up to $N = 12$ sites.

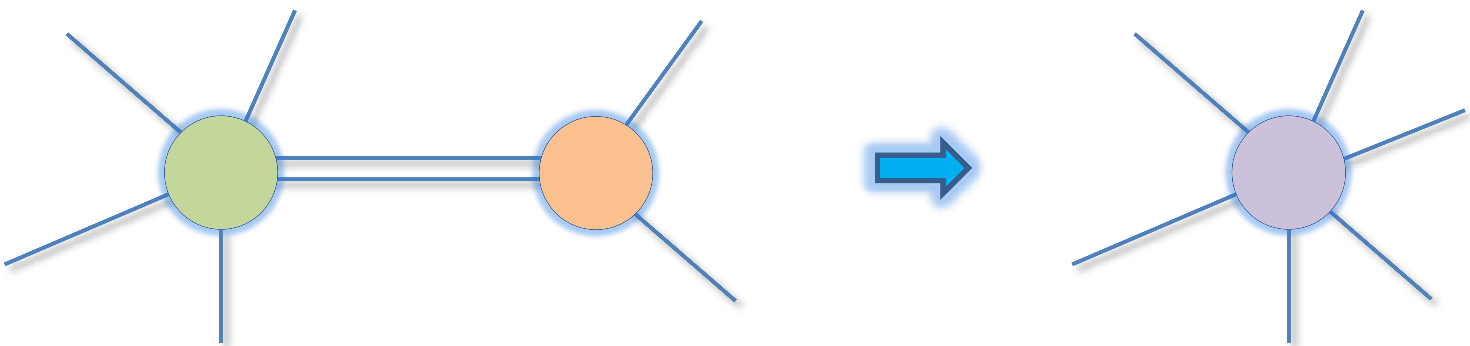
$$H = \sum_{i=1}^{N-1} \vec{S}_i \cdot \vec{S}_{i+1} = \frac{1}{4} \sum_{i=1}^{N-1} \vec{\sigma}_i \cdot \vec{\sigma}_{i+1}$$

- Plot the (per-site) ground-state energy $E(N)/N$ as a function of N. Compare it with the exact solution $\lim_{N\to\infty} E(N)/N = \frac{1}{4} - \ln 2$ which is valid in the thermodynamic limit.

SS2021: Tensor Networks
Institut für Theoretische Physik, TU Dresden
Lecturer: Hong-Hao Tu
Tutorial: 22.04.2021

Remarks:

- For both exercises, it would be convenient if you have a general "contract" function. This will be extensively used in Tensor Networks.



Remarks:

- For exercise 2 (and many other MPS algorithms), the following function would be rather useful: