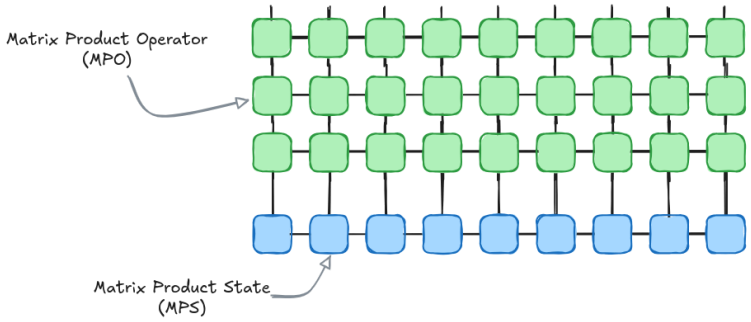
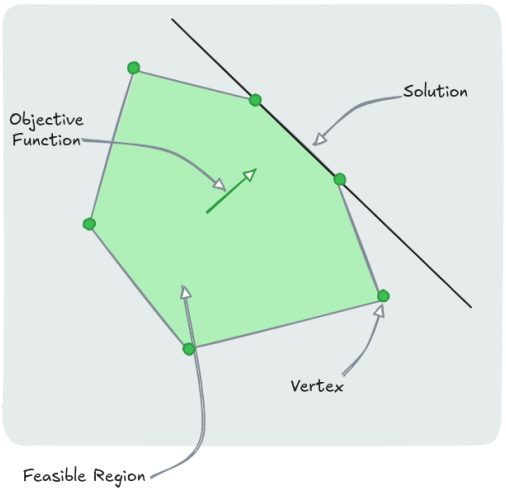
Computational Methods in Quantum Information

Seminar conducted by Patrick Emonts





This course explores the intersection **quantum information theory** and **quantum many-body physics**, equipping students with the theoretical tools and conceptual framework to tackle some of the most profound questions in modern physics.

The different viewpoints of quantum information and quantum many-body theory are unified through mathematical techniques such as **semi-definite programming** and **tensor networks**, which are at the heart of modern research in quantum computing, quantum simulation, and condensed matter theory.

The seminar will be structured in **two parts**. In the first part, we will introduce the necessary concepts:

1. Introduction to Quantum Information: Entanglement and Nonlocality
2. Tensor Networks: Construction and Algorithms: Matrix Product States (MPS), Projected Entangled Pair States (PEPS)
3. Semi-Definite Programs: Definition and Properties, applications in e.g. quantum state discrimination, entanglement detection

In the **second part**, the **students will present selected, recent papers** from the field to get an impression of the current research.

This course is **intended for Master's students with an interest in theoretical and computational physics**. It is particularly suited for those considering research in quantum computing, condensed matter theory, quantum simulation, or related areas. While the course “Theory of Quantum Information” by Koenraad Audenaert is not a prerequisite, it is recommended.

For questions, please contact Dr. Patrick Emonts (patrick.emonts@uni-ulm.de).