TMQS Summer School – Miniproject 2

Quantum Fourier Transform

In this miniproject, you will simulate one of the most crucial algorithms in quantum computing: the quantum Fourier transform (QFT). This quantum analog of the classical discrete Fourier transform plays a significant role in many quantum algorithms, including Shor's algorithm for integer factorization and the quantum phase estimation algorithm. The project is divided in two parts:

Part 1: Tensor-Based Representation of Quantum States and Operations

In the first part, we will focus on representing quantum states and quantum operations using tensors. Recapitulate Define how quantum states are represented as tensors and define common quantum gates (Hadamard, phase shift, controlled gates) as tensor operations. We exploit Scikit-TT to construct the QFT circuit using the defined quantum gates.

Part 2: Simulation and Analysis of the QFT

In the second part, we will simulate the QFT in the Scikit-TT as well as Qiskit framework on various input states and analyze the results. We analyze the results by comparing the simulated outputs in terms of, e.g., runtimes. The aim is to gain a comprehensive understanding of both the theoretical and practical aspects of the QFT.