Master thesis: Implementation of Quantum Control Algorithms for Applications in Biomedical Spectroscopy and Quantum Computing

About

We are seeking to implement advanced algorithms for solving problems in the area of quantum optimal control in `C++`. One major challenge in modern quantum physics and spectroscopy is the design of experiments that are robust with respect to various parameters such as drift and noise. However, the complex mathematical nature of solving the Schrödinger equation rarely allows for analytical solutions. In the past decades a variety of methods have emerged to remedy this obstacle by recasting the quantum control problem as a numerical optimization problem taking advantage of sophisticated existing optimizers. In this programming project we will implement a variety of quantum control algorithms and probe their efficiency and numerical accuracy in solving quantum control problems. These results are vitally important in a multitude of disciplines ranging from physics to chemistry, biology and medicine.

Requirements

- Experience with `C++` programming and parallelization
- Experiece with `GPU/CUDA` programming (preferable, not mandatory)
- Experience with `Python` and `MATLAB` (preferable, not mandatory)
- Good knowledge of matrix algebra and calculus
- Knowledge about quantum physics is not required
- Especially suitable for students with the field of study in computer science, computational engineering, electrical engineering, physics, mathematics or related (m/f/x)
- Language: German or English
- Duration: 6 or 12 months
- Location: remote
- Starting date: flexible

Tasks

- Efficient CPU/GPU implementation of quantum algorithms using parallelization
- Translation of existing `Python` and `MATLAB` code to `C++`
- Probing the impact of the Hessian and Hessian regularization on the convergence rate during quantum control optimizations
- Benchmark algorithmic performance with respect to accuracy and efficiency

What we offer

- Well-rounded and well-structured master thesis project applying advanced cutting-edge computational methods to quantum control problems
- Well-documented `C++` quantum framework already available
- Direct application of developed algorithms to solve spectroscopical problems (spectroscopy performed by supervisor)
- Gaining experience on many levels of scientific programming such as high-level numerical implementations, non-linear optimization, code acceleration, sparse matrix algebra, approximation methods
- Interdisciplinary project at the interface of mathematics, physics, biology, medicine, chemistry and computer science
- Experienced mentoring and patient, individual supervision

Application

Please send your application including Bachelor certificate and Master interim report to:

Technical University of Munich (TUM)
TUM School of Natural Sciences, Department of Bioscience
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