Master thesis:

Quantum decomposition approaches to the Vehicle Routing Problem

Topic description

Since its introduction in 1959 The Vehicle Routing Problem (VRP) has been extensively studied ([1]). The large interest in the VRP is not only due to its computational difficulty but also because of its practical relevance. The VRP deals with the task of distributing goods from a depot to a set of customers with demands. Customers and depot a connected by a road network where each connection is assigned a cost value. A set of vehicles, initially located at the depot, is available, each with a given capacity. Now the task is to assign a route to each vehicle such that all customer demands are satisfied. We aim to find a cost minimizing solution to the VRP.

Quantum computers offer new solutions approaches for combinatorial optimization problems such as the VRP ([2],[3]). However not all tasks a suitable for quantum computers, in particular when considering the limitations of current available quantum hardware. Thus, in order to efficiently exploit the capabilities of quantum computers it is necessary to identify subproblems to be solved by a quantum algorithm.

The goal of this thesis is to develop and analyze quantum-assisted solution approaches for the VRP. This will be done by applying decomposition techniques leading to subproblems suitable for quantum computation. For example, in a classical column generation approach to the VRP several Traveling Salesman Problems (TSP) occur as subproblems. A question to be answered by the thesis could be whether and how those TSPs can be approximately solved by quantum computation.

Preknowledge in quantum computation is not required, however basic familiarity with discrete optimization is preferred.

This thesis will be supervised jointly by the the Department of Data Science and the Fraunhofer IIS.

Contact

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In case of interest please send an email including a Transcript of Records, a short Letter of Motivation as well as a preferred starting date.

References

[1] Paolo Toth and Daniele Vigo. *The vehicle routing problem*. Society for Industrial and Applied Mathematics, 2002.

[2] Michael A. Nielsen and Isaac L. Chuang. *Quantum Computation and Quantum Information: 10th Anniversary Edition*. Cambridge University Press, 2010.

[3] Ashley Montanaro. Quantum algorithms: an overview. *npj Quantum Information*, 2(1), jan 2016.