1 Introduction

The rapid development of modern technology has led to an increased demand for computational power. The classical computers we are familiar with today have certain limitations, and at some point in the (not-so) dinstant future we will reach a cap where the computational power achievable in a single (classical) processor unit will reach a limit. While the processing power may reach a limit, the processing needs of the world will not. This paves the way for a new era of computing, quantum computing.

Quantum computers are based on the principles of quantum mechanics, and have the potential to solve problems that are infeasible for classical computers, and also out-perform classical computers on certain metrics. Where a classical computer uses bits to represent information, a quantum computer uses quantum bits, or qubits, which have the possibility to contain more information per bit than a classical bit. This is due to the fact that a qubit can be in a superposition of states, and can also be entangled with other qubits. In this numerical report, we will explore the basics of quantum computing, and implement a simple quantum algorithm using our own code, the Variational Quantum Eigensolver, as well as comparing certain aspects of our code with the well-established QisKit library. We will be working with two different Hamiltonians. The first Hamiltonian is a simple one, which introduces the basics concepts for quantum computing and the VQE algorithm.
The second Hamiltonian is the Lipkin model.
Firstly, we will introduce necessary theory and concepts, and their numerical implementations, in the theory and method section. Then, we will present our results, and discuss these in the result section. Finally, we will conclude our findings and discuss the potential of quantum computing in the future.