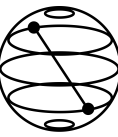
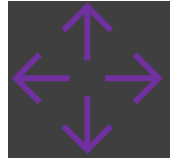


Introduction to QAOA with Qiskit



Masters Students (with basic knowledge in CS & QC)



Lecture Outline

Introduction & Motivation (5min)

Motivating & brief intro to QAOA

Theory (10min)

Optimization, Quantum Annealing, Hamiltonian, Adiabatic theorem, QAOA, MaxCut Problem

QAOA using Qiskit (30min)

Implementing QAOA from scratch & within the Qiskit routine

QAOA in Practice (5min)

Outlook and homework exercise

Theory

Cost function

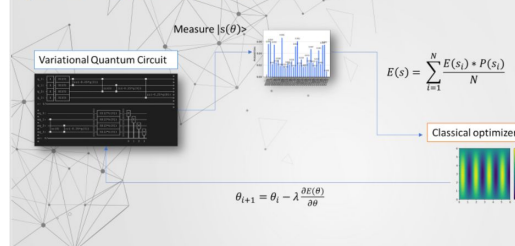
$$C(x) = \sum_{i,j=1}^n x_i Q_{ij} x_j + \sum_{i=1}^n c_i x_i$$

QUBO cost function \rightarrow Hamiltonian

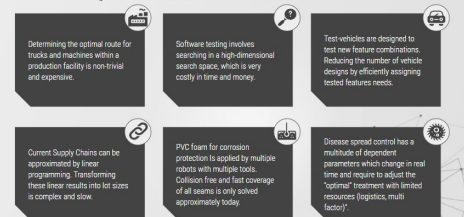
Maximize $C(x) \Leftrightarrow$ find the ground state* of the Hamiltonian

*System is in its ground state when the corresponding energy is minimal

QAOA - An Overview



Outlook to QAOA applications in the far future



Practice

```
def compute_expectation(qubo: QuadraticProgram, counts):  
    """  
    Computes expectation value based on measurement results  
    Args:  
        counts: dict  
                Key as bitstring, val as count  
        qubo: The quadratic qubo instance  
    Returns:  
        avg: Expectation value  
    """
```

```
def compute_energy(qubo: QuadraticProgram, x: str):  
    """  
    Given a bitstring as a solution, returns  
    the corresponding energy according to given QUBO.  
    Args:  
        qubo: The quadratic qubo instance  
        x: Solution bitstring  
    Returns:  
        e: Energy  
    """
```

