

Quantum projects

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This provides my hands-on experience in quantum technologies using various IDE, tools and languages. Few key projects are developed using IBM Qiskit, Google Cirq, Azure Quantum, Xanadu Strawberry Fields and PennyLane libraries. More details can be provided upon request.

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Key projects in areas of Quantum Technologies

Proj. No.	Project Name/ Year	Project Summary /Learning	GitHub Repository
1	QSAM simulator - 2021	Build a quantum circuit for QSAM simulator backend and IBM Qiskit	https://github.com/vijaymohire/quantum/blob/main/Qasm%20simulator.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/QASM%20circuit%20-%20IBM%20Quantum.pdf
2	Single qubit operations-2021	The Pauli Gates: X-Gate, Y & Z-Gates , The Hadamard Gate, The P-gate, The I, S and T-gates and The General U-gate using IBM Qiskit	https://github.com/vijaymohire/quantum/blob/main/single-qubit-gates.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/IBM%20Qiskit%20-%20Single-qubit-gates.pdf
3	Single qubit probability-2021	This solution offers the way to find the probability of a qubit, rotated in the y axis with a certain pi value and measuring the results using count, build using IBM Qiskit	https://github.com/vijaymohire/quantum/blob/main/Probability_of_single_qubit.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/Probability_of_single_qubit.pdf
4	Representing multi qubits-2021	Representing multi qubits superposition and entanglements using statevectors and amplitudes using IBM Qiskit	https://github.com/vijaymohire/quantum/blob/main/Multi-Qubit_Entanglement.ipynb PDF https://github.com/vijaymohire/quantum/blob/main/Entangle%20ci

			rcuit%20-%20IBM%20Quantum.pdf https://github.com/vijaymohire/quantum/blob/main/IBM%20Qiskit%20-%20Multi-Qubit Entanglement.pdf
5	Quantum neural network-2021	We have this notebook sample that demonstrates the different generic quantum neural network (QNN) implementations provided in Qiskit Machine Learning. The networks are meant as application-agnostic computational units that can be used for many different use cases	https://github.com/vijaymohire/quantum/blob/main/Quantum-NeuralNW.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/Quantum-NeuralNW.pdf
6	Hybrid quantum-classical Neural Networks-2021	Hybrid quantum-classical Neural Networks with PyTorch and Qiskit. We explore how a classical neural network can be partially quantized to create a hybrid quantum-classical neural network	https://github.com/vijaymohire/quantum/blob/main/Hybrid%20quantum-classical%20NNW%20with%20PyTorch%20and%20Qiskit.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/IBM%20Qiskit%20-%20Hybrid%20quantum-classical%20NN%20with%20PyTorch%20and%20Qiskit.pdf
7	Grover's Algo-2021	Grover's Algorithm using 2 qubit to test the probability of the base state values run in real quantum machine	https://github.com/vijaymohire/quantum/blob/main/GroversAlgo.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/IBM%20Qiskit%20-%20Grover'sAlgo.pdf
8	Quantum Fourier Transform-2021	Executed QFT sample from link using IBM Quantum lab and Qiskit	https://github.com/vijaymohire/quantum/blob/main/QFT.ipynb

			PDF: https://github.com/vijaymohire/quantum/blob/main/IBM%20Qiskit%20-%20Multi-Qubit Entanglement.pdf
9	Google Cirq Circuits - 2021	Implement basic quantum gates using Google's Cirq. Google Cirq Circuits demonstration that shows the use of Cirq libraries in designing quantum circuits with qbits and qgates	https://github.com/vijaymohire/quantum/blob/main/Cirq-circuits.ipynb
10	Google Cirq simulation-2021	Google Cirq simulation demonstrates various simulation available, pure and mixed and use of related functions	https://github.com/vijaymohire/quantum/blob/main/Cirq-simulation.ipynb
11	TFQ Hello World-2021	TFQ "Hello World" sample demo run in Google Colab, demonstrating the capabilities of Cirq and TensorFlow Quantum that enable effective use of Tensorflow and ML for Quantum error correction, which is a big research area	https://github.com/vijaymohire/quantum/blob/main/TensorFlow%20Quantum-hello_many_worlds.ipynb
12	Quantum GAN-2021	Quantum Generative Adversarial Networks with Cirq + TensorFlow	https://github.com/vijaymohire/quantum/blob/main/QGAN%20using%20Cirq%20and%20TensorFlow.ipynb
13	Quantum CNN-2021	Quantum CNN sample run in Google Colab using Tensorflow, Neural Networks and Quantum circuits fed to the neural networks	https://github.com/vijaymohire/quantum/blob/main/QuantumCNN.ipynb
14	Find Eigen values-2021	Use of Python to visualize the wave functions and different energy levels for a particle in a box using shooting method. Plots offer great visualization of the energy levels.	https://github.com/vijaymohire/quantum/blob/main/Quantum%20%20Physics-%20Find%20Eigen%20values%20in%20Python.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/Quantum%20Physics-

			%20Find%20Eigen%20values%20in%20Python.pdf
15	Quantum Computing Notes Ver 1.2 - 2022	Collection of academic and course learning	https://github.com/vijaymohire/quantum/blob/main/Quantum%20Computing%20Notes%20Ver%201.2.pdf
16	Majorana Zero Modes-2022	Python notebook and PDF, demonstrating Majorana zero modes in a simulated mathematical model and plotting the same	https://github.com/vijaymohire/quantum/blob/main/Majorana%20zero%20modes.ipynb PDF: https://github.com/vijaymohire/quantum/blob/main/Majorana%20zero%20modes.pdf
17	Demo for photonics-2022	PennyLane notebook for photonics using PennyLane libraries and Xanadu cloud for various photon operators like displacement and squeezed state	https://github.com/vijaymohire/quantum/blob/main/demo_photonics.ipynb
18	Gamma_Function -2022	One of the key maths functions used in quantum technology. It is often referred to as the generalized factorial, this is a standard as per NIST Digital Library of Mathematical Functions https://dlmf.nist.gov/5.2#E1	https://github.com/vijaymohire/quantum/blob/main/Gamma_Function.ipynb
19	Boson sampling-2022	Boson sampling using quantum linear optics, an array of single-photon sources and a multimode linear interferometer. Use of Xanadu's Strawberry Fields library.	https://github.com/vijaymohire/quantum/blob/main/Boson%20Sampling.ipynb
20	Azure Quantum-2022	Directions to use Azure quantum with few examples using Qiskit and IonQ processors	https://github.com/vijaymohire/quantum/blob/main/Azure%20Quantum%20with%20IBM%20Qiskit%20and%20IonQ%20QPU.pdf
21	Azure Quantum Workspace - 2022	Introduction to Azure Quantum Workspace along with sample example to develop Q# code	https://github.com/vijaymohire/quantum/blob/main/Azure%20Quantum%20Workspace.pdf PDF: https://www.slideshare.net/slides

			hows/azure-quantum-workspace-for-developing-q-based-quantum-circuits/266701455
22	Molecular Hamiltonian - 2022	<p>In computational chemistry, we are typically interested in finding the ground-state energy (i.e., minimum energy) of a molecule for a given configuration of atomic positions. This is accomplished by finding the lowest eigenvalues and eigenstates of the molecular Hamiltonian.</p> <p>In this notebook, we illustrate how to implement the Variational Quantum Eigensolver (VQE) algorithm in Amazon Braket SDK to compute the potential energy surface (PES) for the Hydrogen molecule. Specifically, we illustrate the following features of Amazon Braket SDK:</p> <ul style="list-style-type: none"> * `LocalSimulator` which allows one to simulate quantum circuits on their local machine * Construction of the ansatz circuit for VQE in Braket SDK * Computing expectation values of the individual terms in the Hamiltonian in Braket SDK 	https://github.com/vijaymohire/quantum/blob/main/VQE_chemistry_braket.ipynb
23	Qubit Examples- 2022	Various functions and examples for using qubits using functions to initialize, transform, measure and validate the results. Simple maths library like NumPy used.	https://github.com/vijaymohire/quantum/blob/main/Qubit_Examples.py
24	Topological quantum computing -2022	Basic concepts of Topological quantum computing. Introduces to Hamiltonian, Eigen values, energy spectrums, Bulk edge, invariants, Kitaev Chain, etc	https://github.com/vijaymohire/quantum/blob/main/Topology_1.ipynb https://github.com/vijaymohire/quantum/blob/main/Topology_2.ipynb
25	Azure Quantum Job-shop-sample- 2022	Job Shop scheduling using Azure Quantum optimization. Problem is mapped to the QUBO model.	https://github.com/vijaymohire/quantum/blob/main/Azure%20Quantum%20Job-shop-sample.pdf

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