



TensorFlow Quantum to build hybrid quantum-classical models



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10 STD, TEDX, Ted-Ed speaker|Google certified mobile site developer|Intel AI Scholar|2XGCP Champ|Mozilla Mumbai Lead

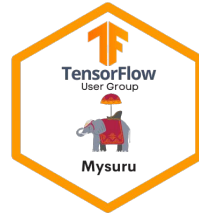


Ideal Audience

- Developers who having worked on Deep Learning Models (Keras)
- Developers eager to learn about how Quantum AI Models could work

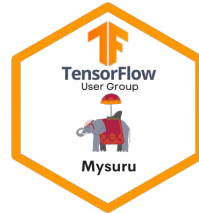


Agenda



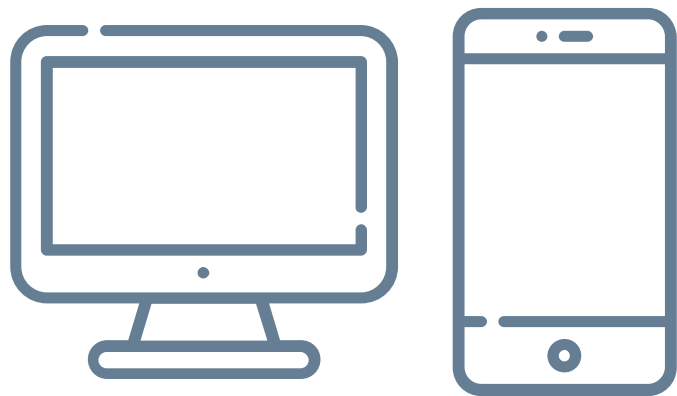
- A Gentle Introduction to Q computing
- Motivation behind Q computing
- Why Hybrid models?
- Why TensorFlow Quantum?
- Building models
- How does TFQ simplify things?
- Demos!!
- Quick Recap
- Q & A

A Gentle introduction to Q Computers



A classical machine

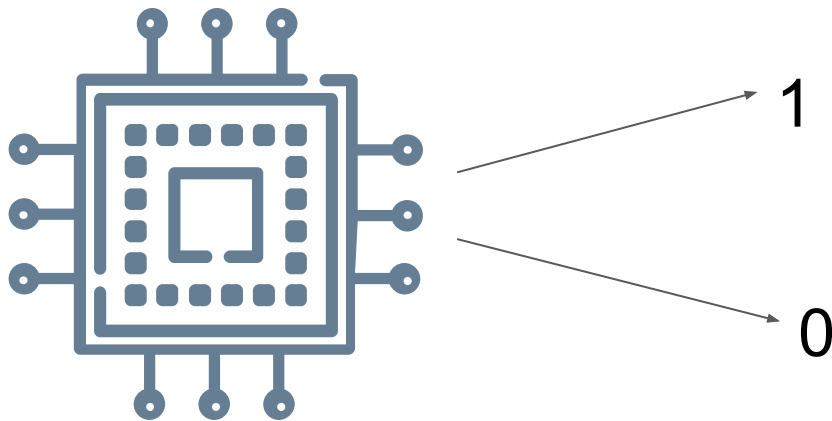
Works on 1 or 0

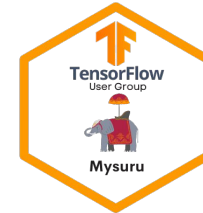




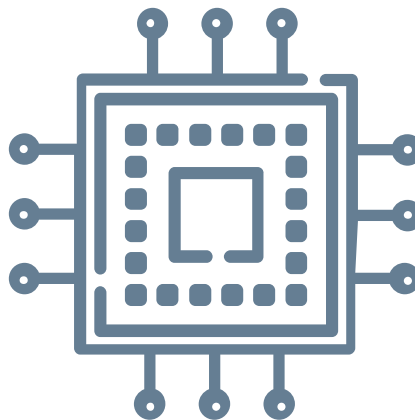
A classical machine

Works on 1 or 0

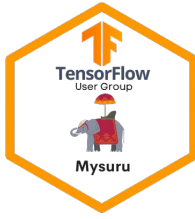




Quantum Computer



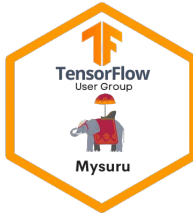
Qubit



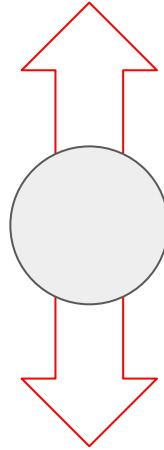
Quantum Computer

1

Qubit

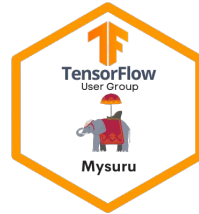


Quantum Computer



$$|\uparrow\rangle = 0.7$$

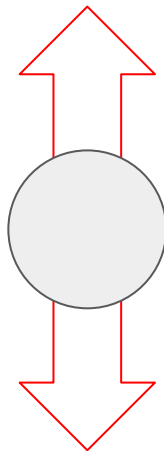
$$|\downarrow\rangle = 0.8$$



Quantum Computer

Quantum
superposition

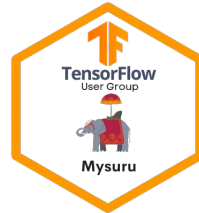
(Just a big word)



$$|\uparrow\rangle = 0.7$$

$$|\downarrow\rangle = 0.8$$

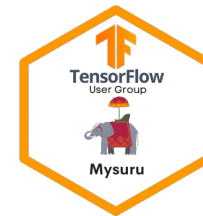
Motivation behind Q computing



Classical computer

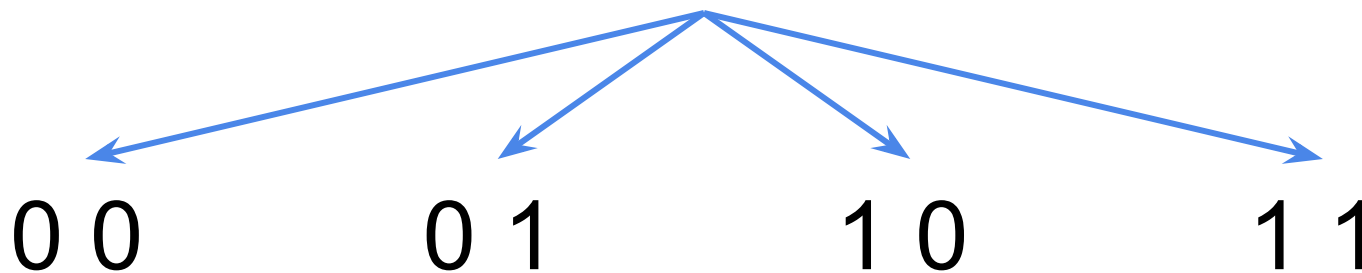
2 bits

(Remember a bit means 0 or 1)

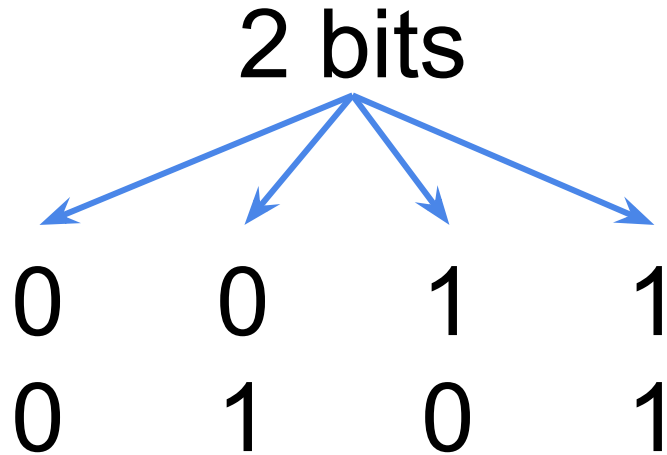


Classical computer

2 bits (4 combinations)

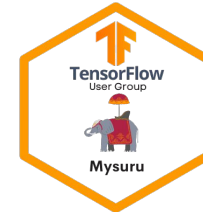


Classical



Quantum

A	0	0
B	0	1
C	1	0
D	1	1

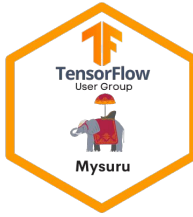


Bits	Qubits
2	4
3	8
4	16



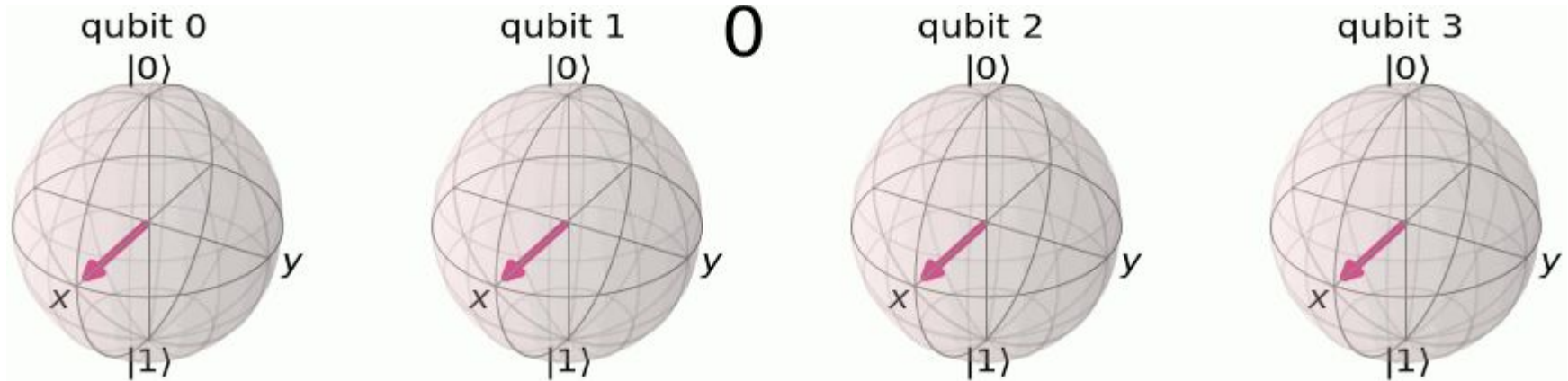
Motivation behind Q computing

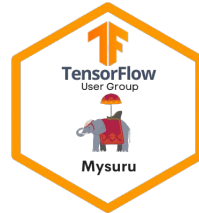
- Exponentially faster!



Motivation behind Q computing

- Exponentially faster!
- 2^n bits

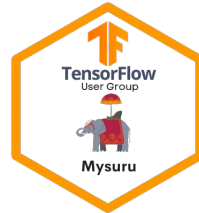




Motivation behind Q computing

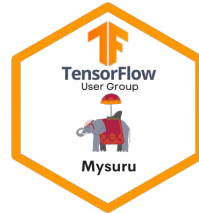
- Exponentially faster!
- 2^n bits
- 300 bits - not enough to store even 1 image
- 300 qubits - number of particles in universe!!

Why Hybrid models?



Why Hybrid models?

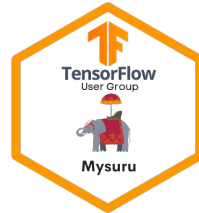
- Faster for ops where superposition can be used



Why Hybrid models?

- Faster for ops where superposition can be used
- Combine them :)

Why TensorFlow Quantum?



Why TensorFlow Quantum?



- Easy and faster development

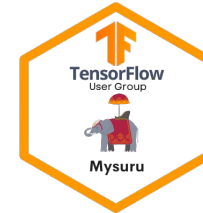


Why TensorFlow Quantum?



- Easy and faster development
- Training can be done using standard Keras functions

Building models



The process

- Quantum Circuit

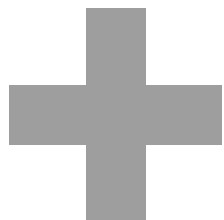


The process

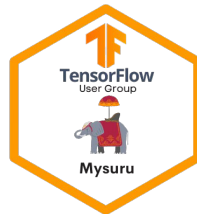
- Quantum Circuit



Cirq

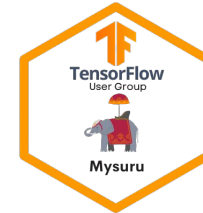


TensorFlow



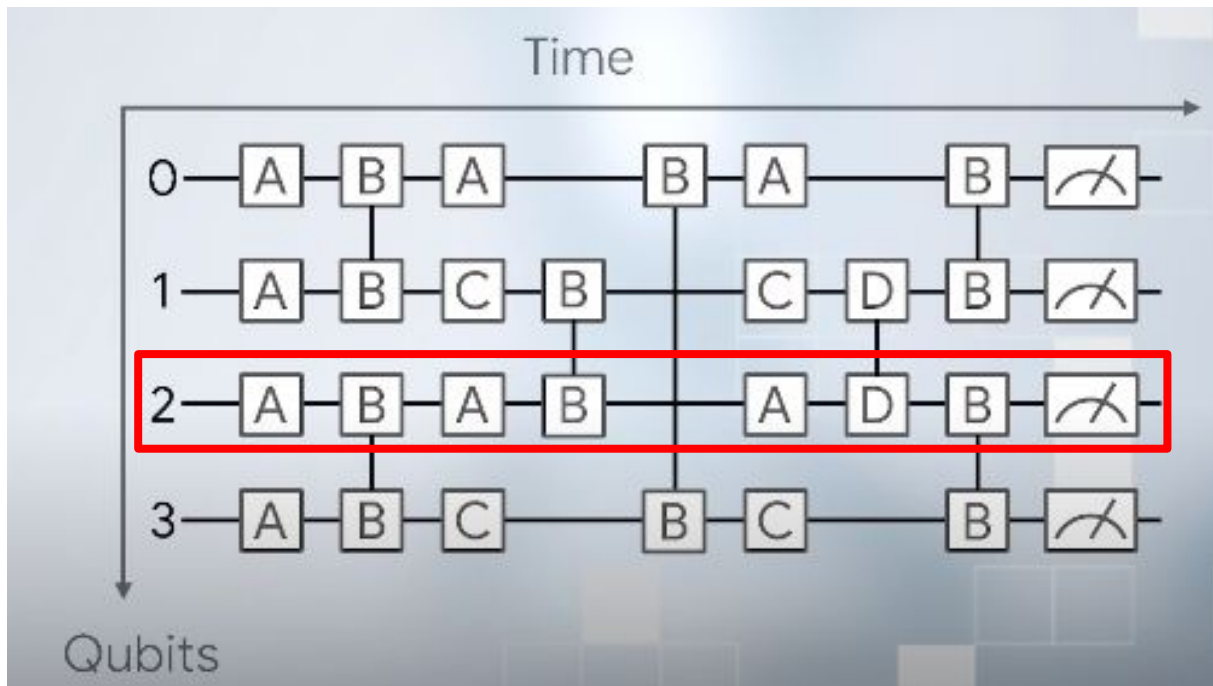
The process

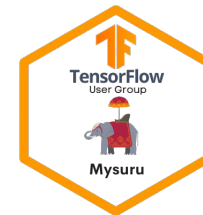




PS: Not as hard as it looks

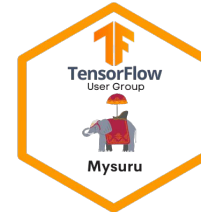
The process



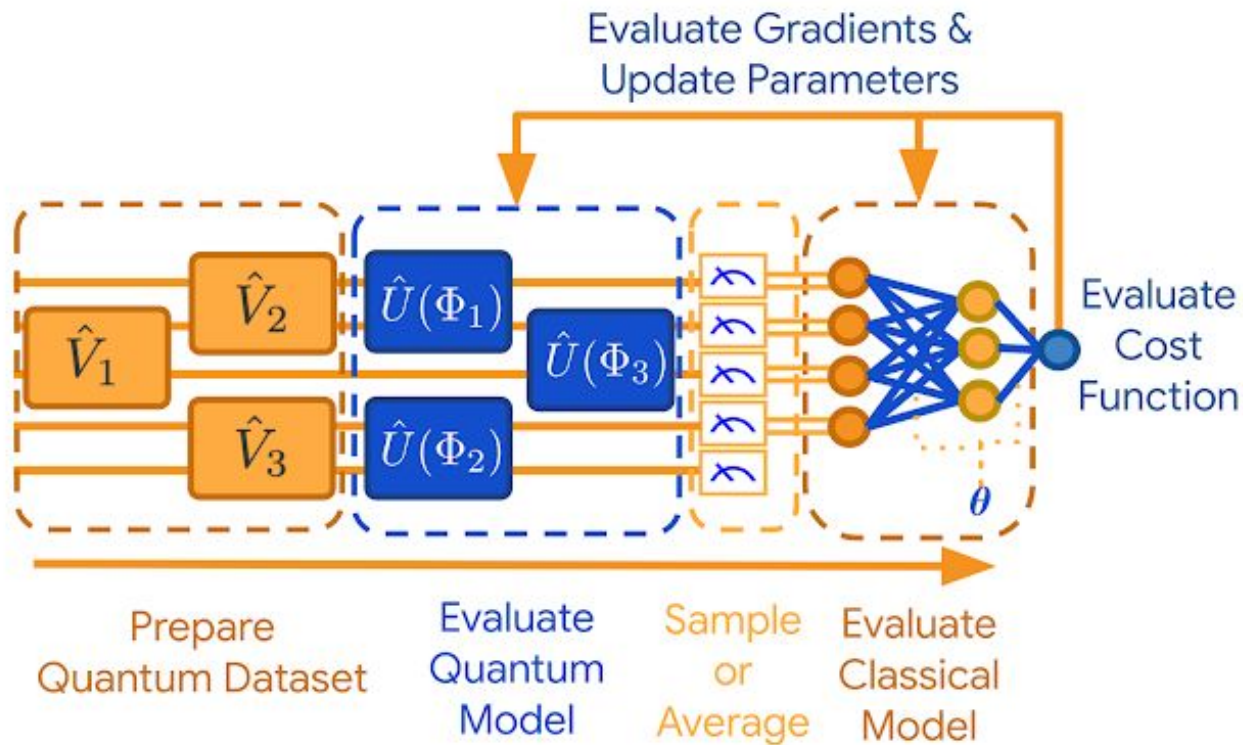


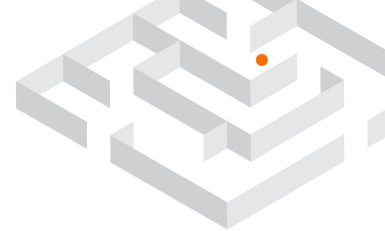
The process





The process





Installation

tensorflow.org/quantum/install



A simple circuit

```
q0, q1 = cirq.GridQubit.rect(1, 2)
```



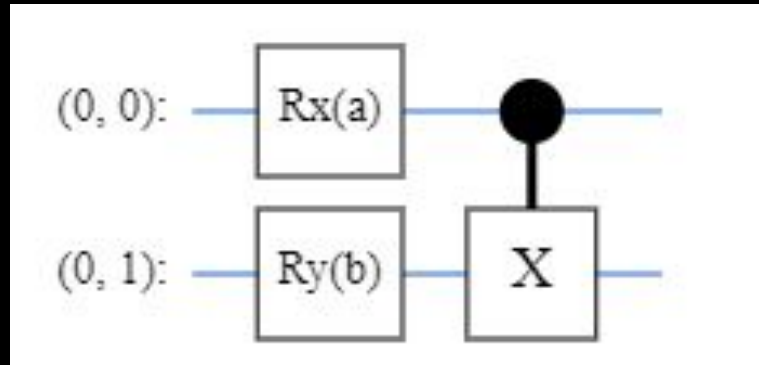
A simple circuit

```
q0, q1 = cirq.GridQubit.rect(1, 2)

circuit = cirq.Circuit(
    cirq.rx(a).on(q0),
    cirq.ry(b).on(q1),
    cirq.CNOT(control=q0, target=q1))
```



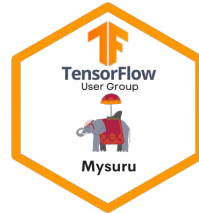
A simple circuit



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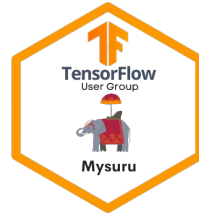
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```

Coding an AI algorithm



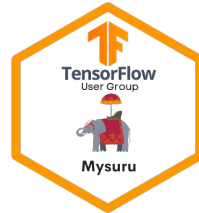
How does TFQ simplify things

- Differentiability



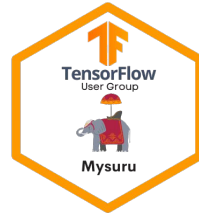
How does TFQ simplify things

- Differentiability
- Parallel circuits




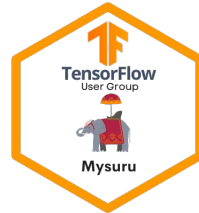
How does TFQ simplify things

- Differentiability
- Parallel circuits
- Easy switching



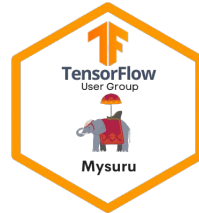
How does TFQ simplify things

- Differentiability
- Parallel circuits
- Easy switching
- Cirq  TensorFlow



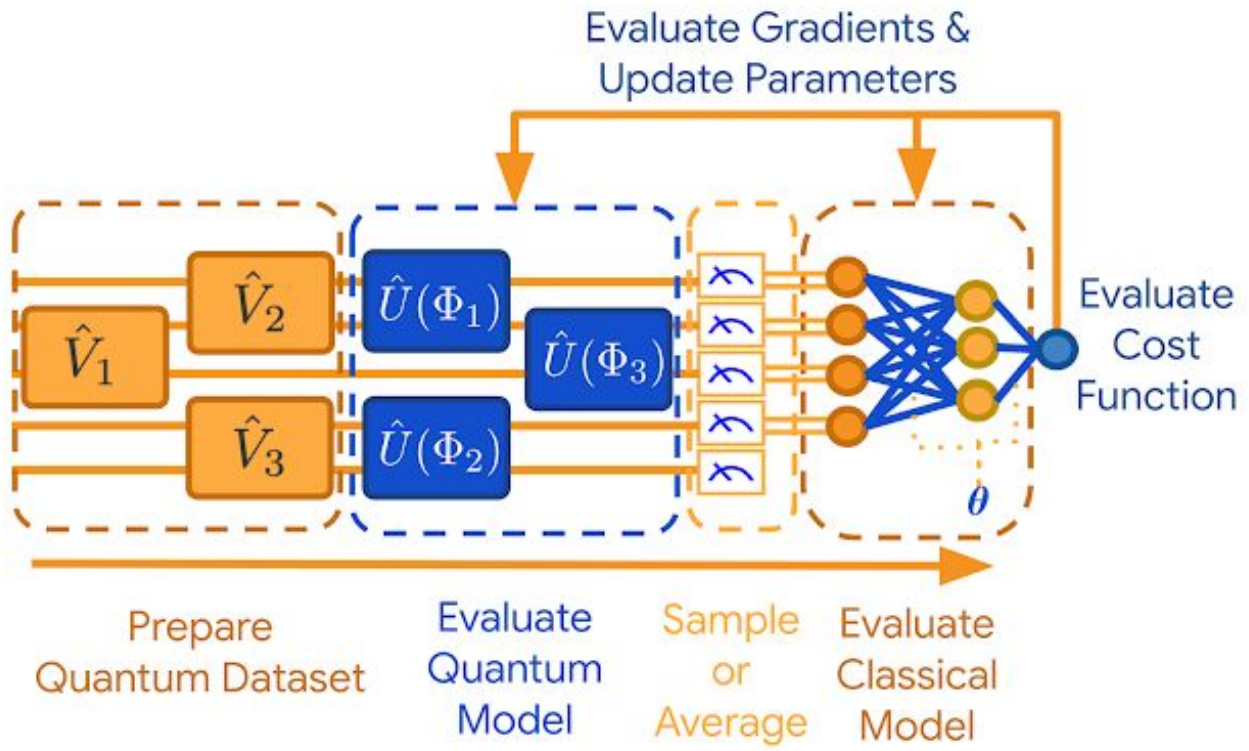
Things to keep in mind

- All circuits are Tensors



Things to keep in mind

- All circuits are Tensors
- Circuits \longrightarrow Classical data can be an op



Demos!

tfug-mysuru.rishit.tech

Code Repo



Demos

Dummy
algorithm

Image
classification

Key Takeaways

- Basics of quantum computing
- Motivation behind quantum computers
- Why hybrid quantum classical models?
- How can TFQ and Cirq help?
- Why use TFQ and Cirq?
- Building a hybrid classical model

About Me



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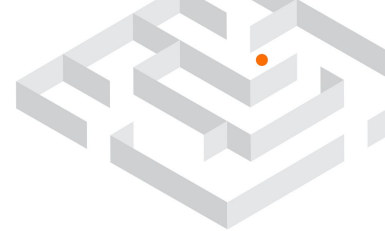
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Code Repo

bit.ly/tfq-slides

Slides



Q & A



THANK YOU

