ಟೆನ್ಸರ್ ಫ್ಲೋ Quantum to build hybrid quantum-classical models

Rishit Dagli (@rishit_dagli)

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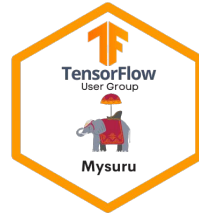
Ideal Audience

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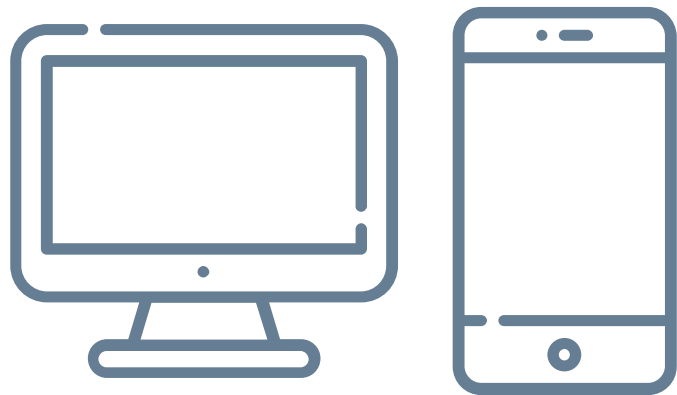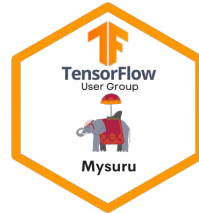- Developers eager to learn about how Quantum AI Models could work

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
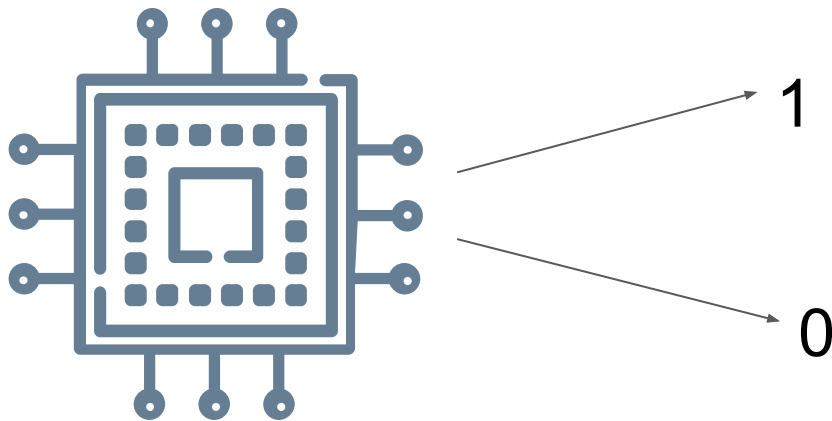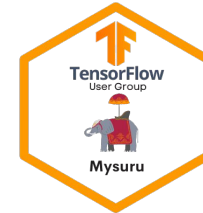
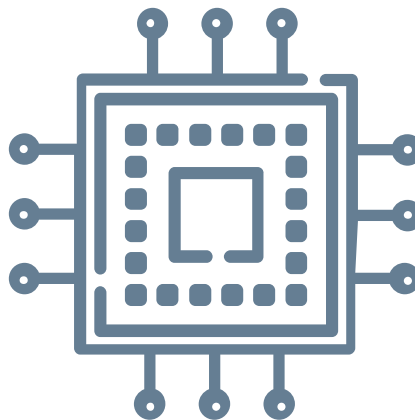# A classical machine
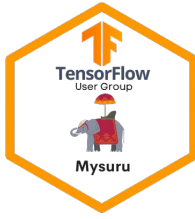
Works on 1 or 0

A classical machine
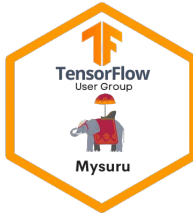
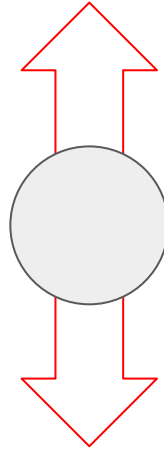Works on 1 or 0

1

0

Quantum Computer

Quibit

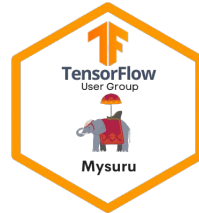# Quantum Computer

1

Quibit
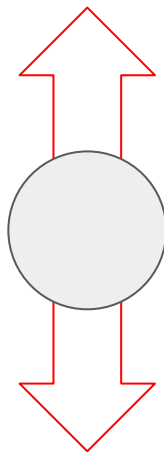
Quantum Computer

$$|\Uparrow\rangle = 0.7$$

$$|\Downarrow\rangle = 0.8$$

Quantum Computer

Quantum
superposition

(Just a big word)

$$\left|\Uparrow\right\rangle = 0.7$$

$$\left|\Downarrow\right\rangle = 0.8$$

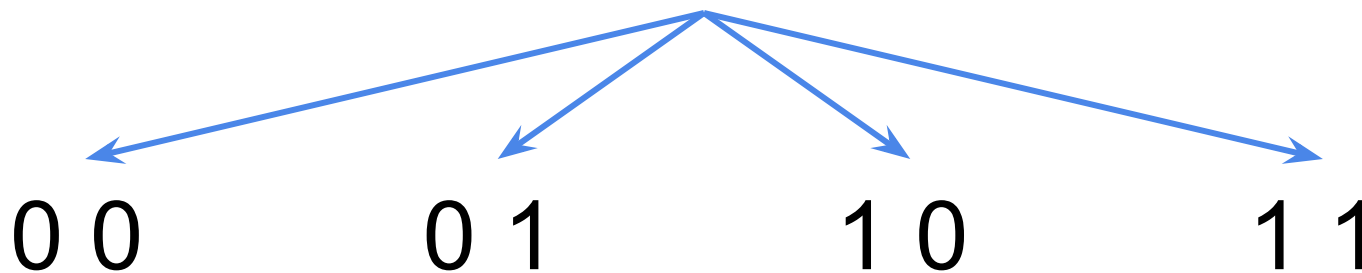# Motivation behind Q computing

Classical computer

2 bits

(Remember a bit means 0 or 1)

Classical computer

2 bits (4 combinations)

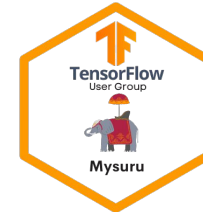0 0   0 1   1 0   1 1

Classical

2 bits

0 0 1 1
0 1 0 1
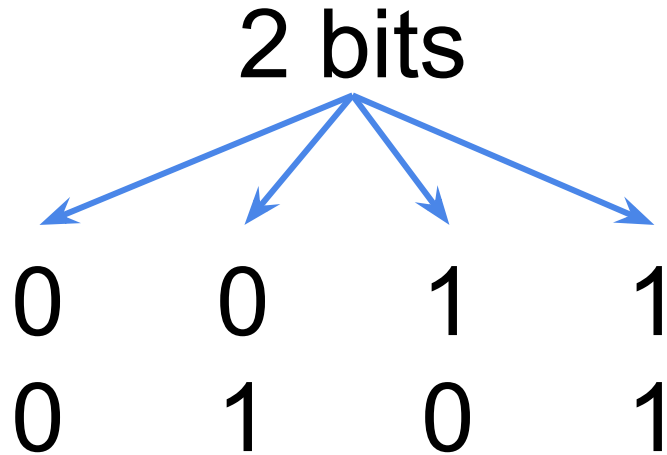
Quantum

A 0 0

B 0 1

C 1 0

D 1 1

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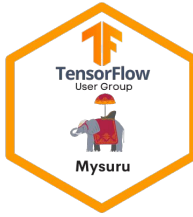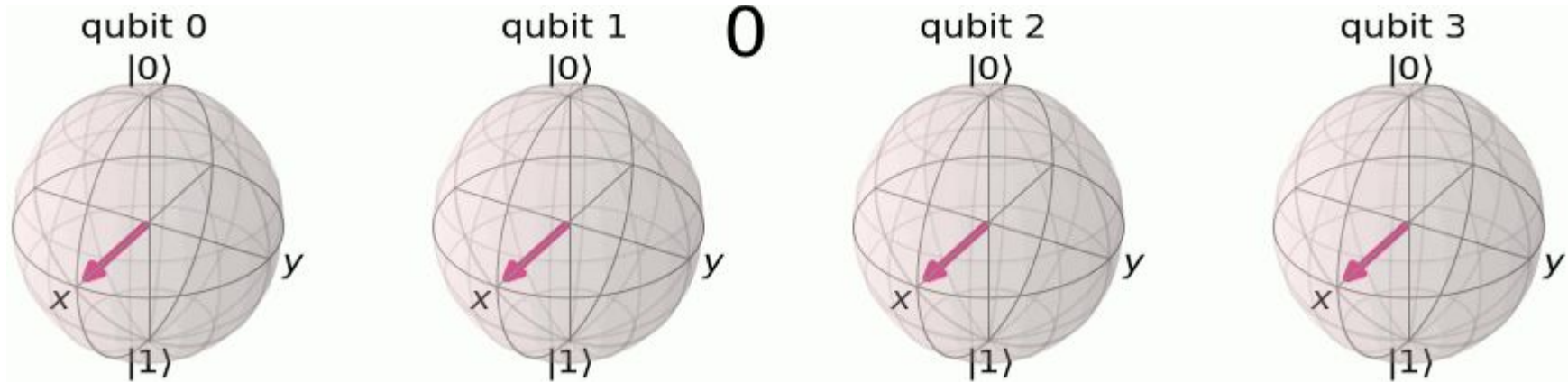
Bits	Qubits
2	4
3	8
4	16

Motivation behind Q computing

- Exponentially faster!

Motivation behind Q computing

- Exponentially faster!
- 2^n bits

qubit 0
$|0\rangle$
x
y
$|1\rangle$

qubit 1
$|0\rangle$
x
y
$|1\rangle$

0

qubit 2
$|0\rangle$
x
y
$|1\rangle$

qubit 3
$|0\rangle$
x
y
$|1\rangle$

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!!

Source: Derek Muller

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Why Hybrid models?

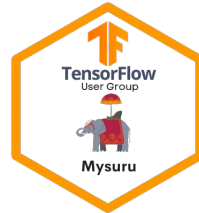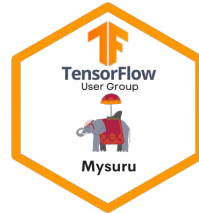# Why Hybrid models?

- Faster for ops where superposition can be used

Why Hybrid models?

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

Why TensorFlow Quantum?

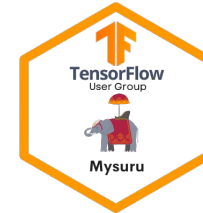# Why TensorFlow Quantum?

- ● Easy and faster development
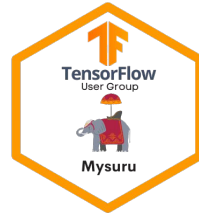
Why TensorFlow Quantum?

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

Building models

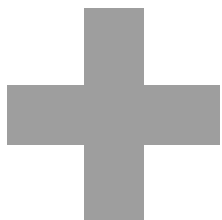# The process

- Quantum Circuit

The process

- Quantum Circuit

PS: Not as hard as it looks

The process

Source: Google AI

PS: Not as hard as it looks

The process

PS: Not as hard as it looks

The process

Quantum gate
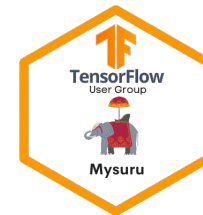
The process
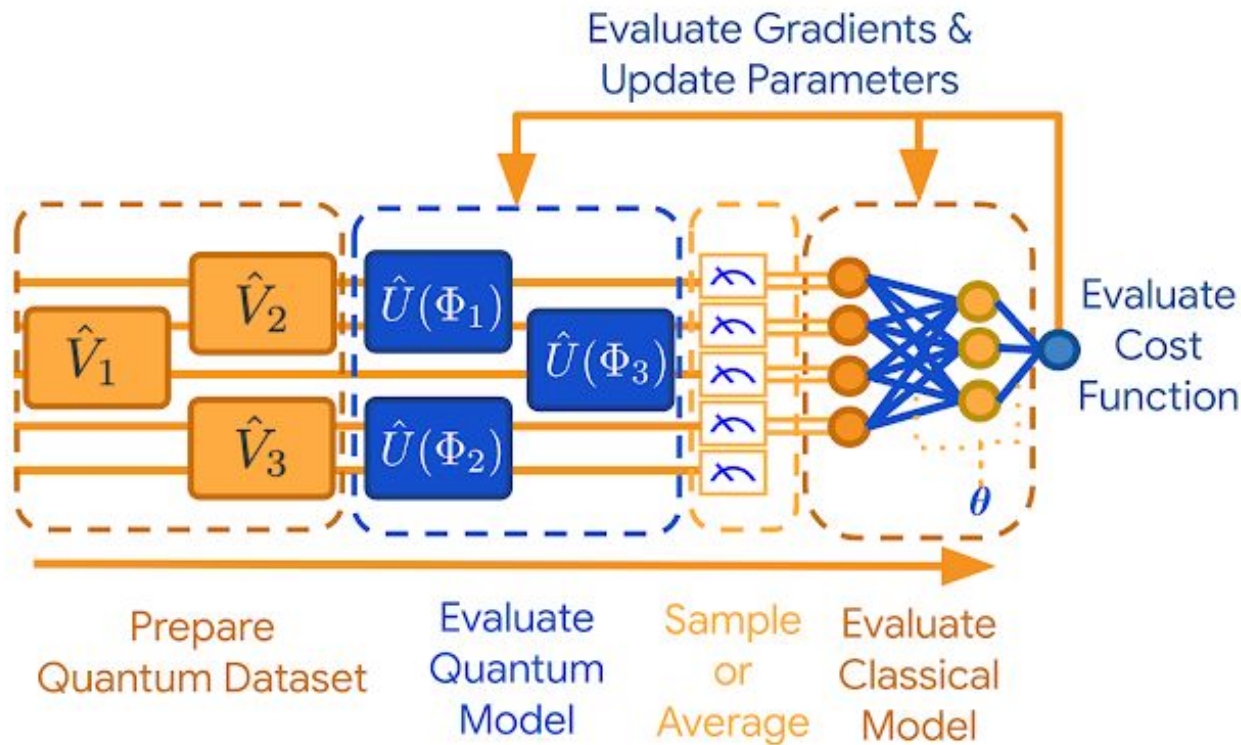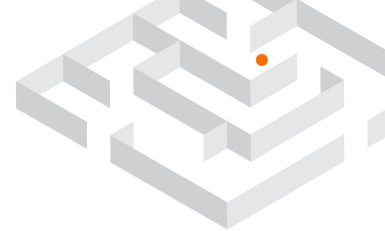
Installation

tensorflow.org/quantum/install

A simple circuit

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

A simple circuit

```python
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))
```
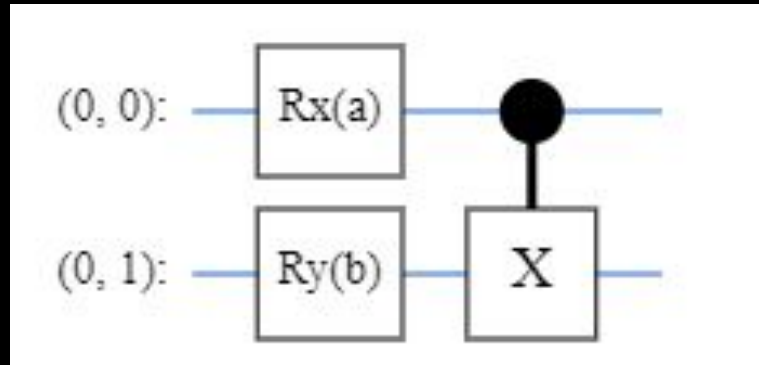
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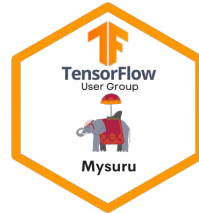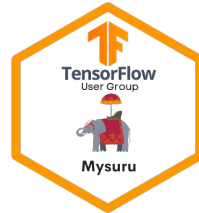
Coding an AI algorithm

How does TFQ simplify things

● Differentiability

How does TFQ simplify things

- Differentiability
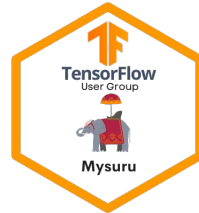- Parallel circuits

How does TFQ simplify things

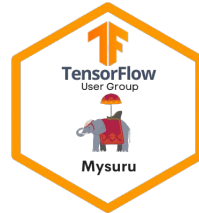- Differentiability
- Parallel circuits
- Easy switching

How does TFQ simplify things

- Differentiability
- Parallel circuits
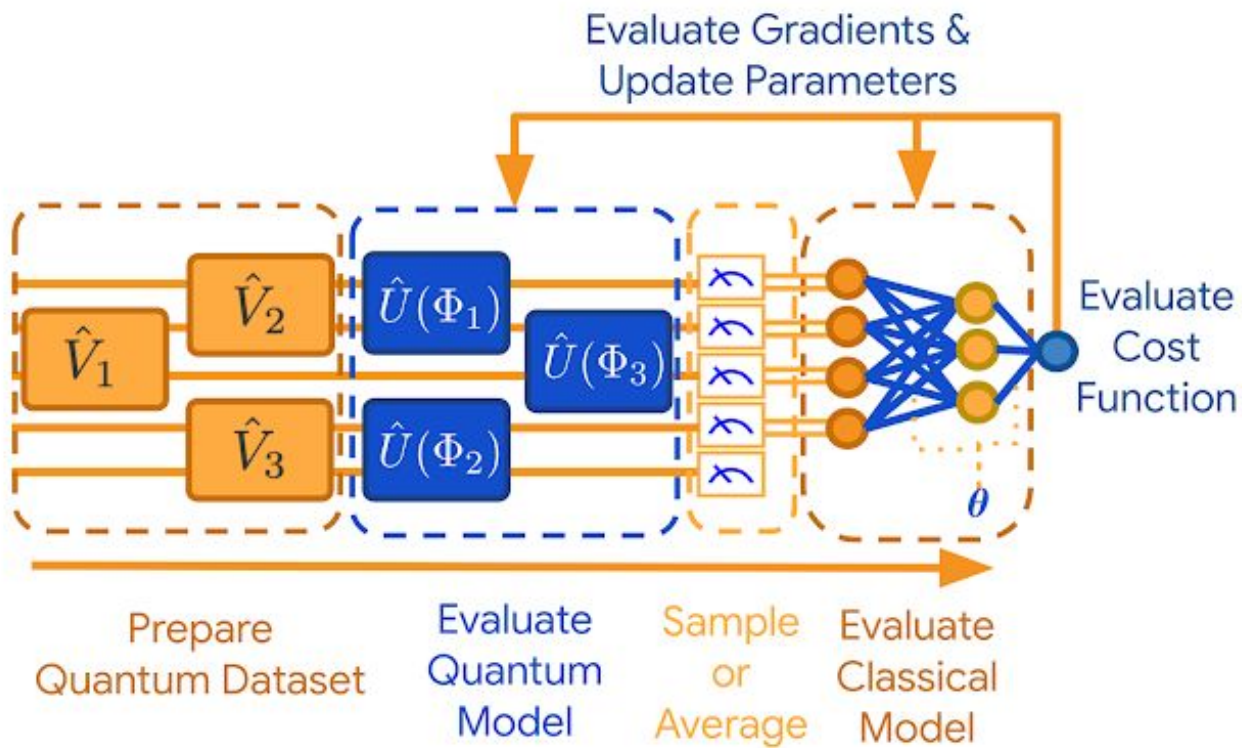- Easy switching
- Cirq 🤝 TensorFlow

Things to keep in mind

- All circuits are Tensors

Things to keep in mind

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

Evaluate Gradients & Update Parameters

$\hat{V}_1$ $\hat{V}_2$ $\hat{V}_3$ — Prepare Quantum Dataset

$\hat{U}(\Phi_1)$ $\hat{U}(\Phi_2)$ $\hat{U}(\Phi_3)$ — Evaluate Quantum Model

Sample or Average

θ — Evaluate Classical Model

Evaluate Cost Function
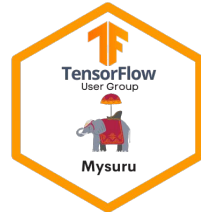
Demos!

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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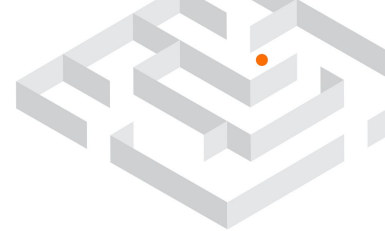
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Code Repo

bit.ly/tfq-slides

Slides

Q & A

THANK YOU