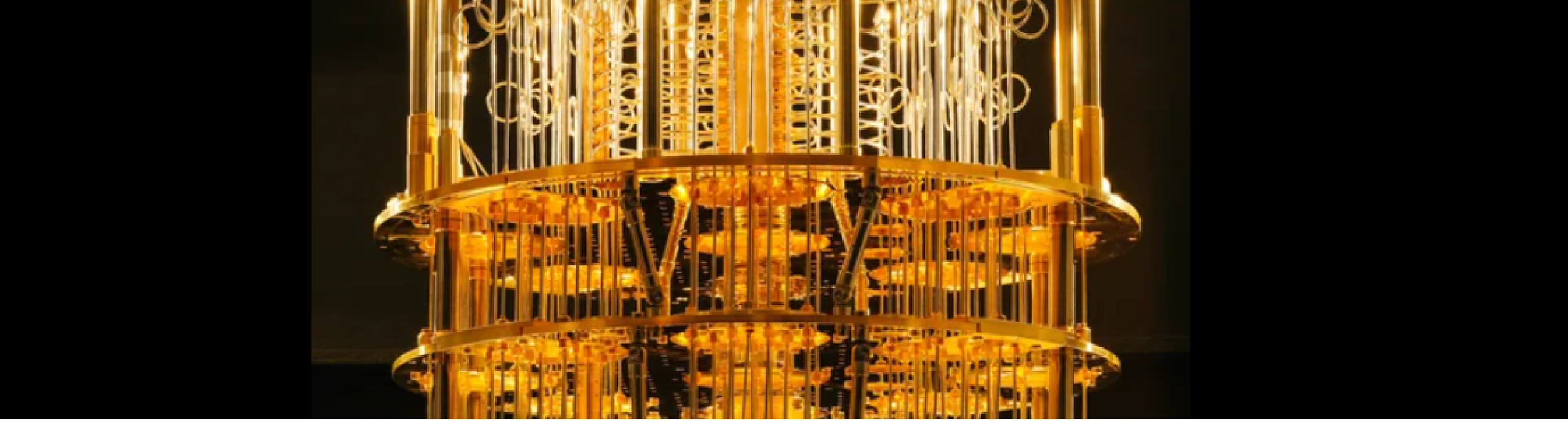

Mental-Health Prediction using QEML

By Group 7

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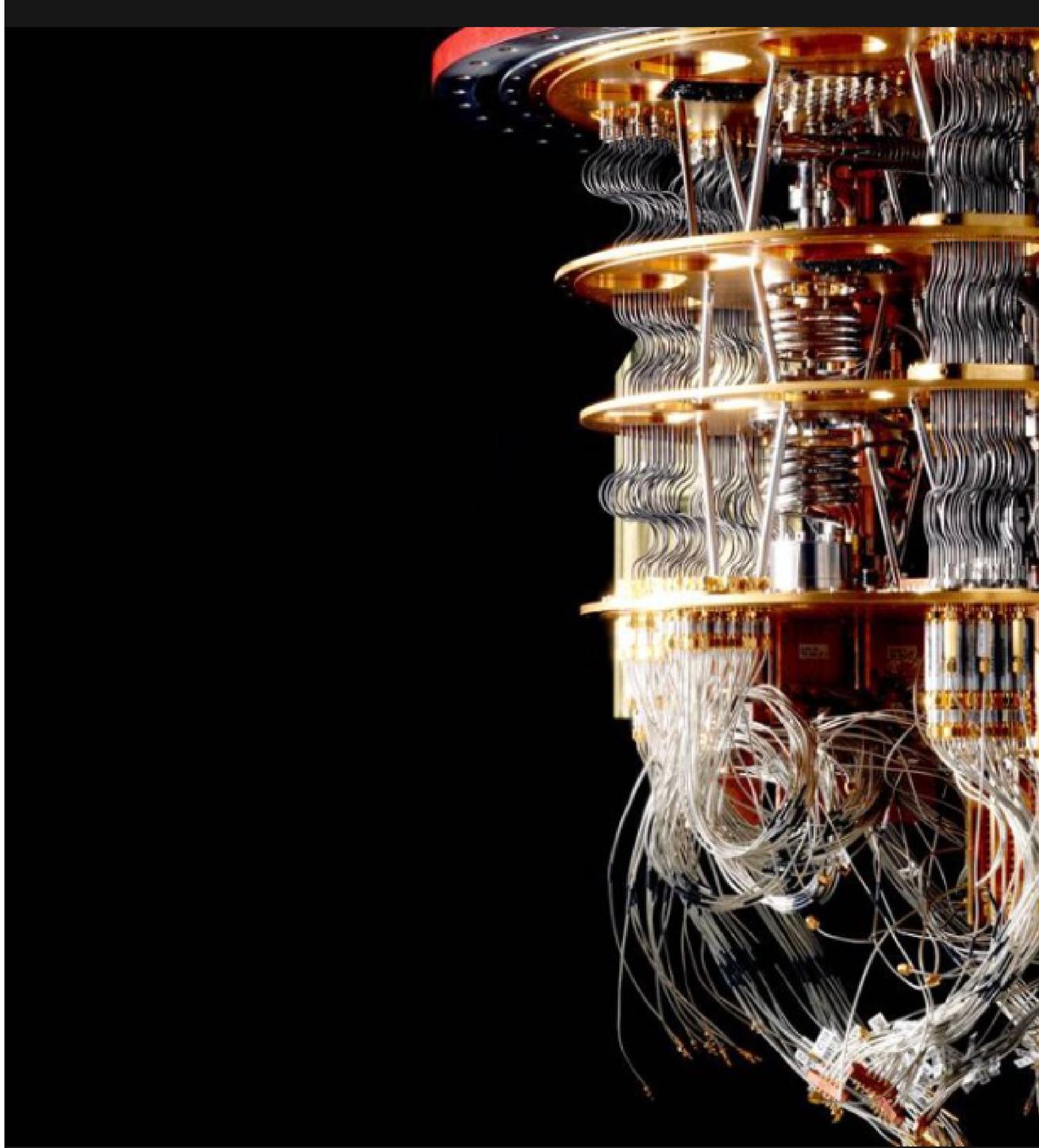
Agenda

- Background & Motivation
- Project Requirements
- Implementation
- Evaluation
- Summary



Background & Motivation

The traditional ML algorithms suffer from 2 disadvantages:

1. "Curse of the Dimentionality".
2. Incresing Time and space complexity with incresing complexity of the models.
3. Problems such as medical conditions similar to one stated in this project, we simply cannot just rely on few features of the dataset.

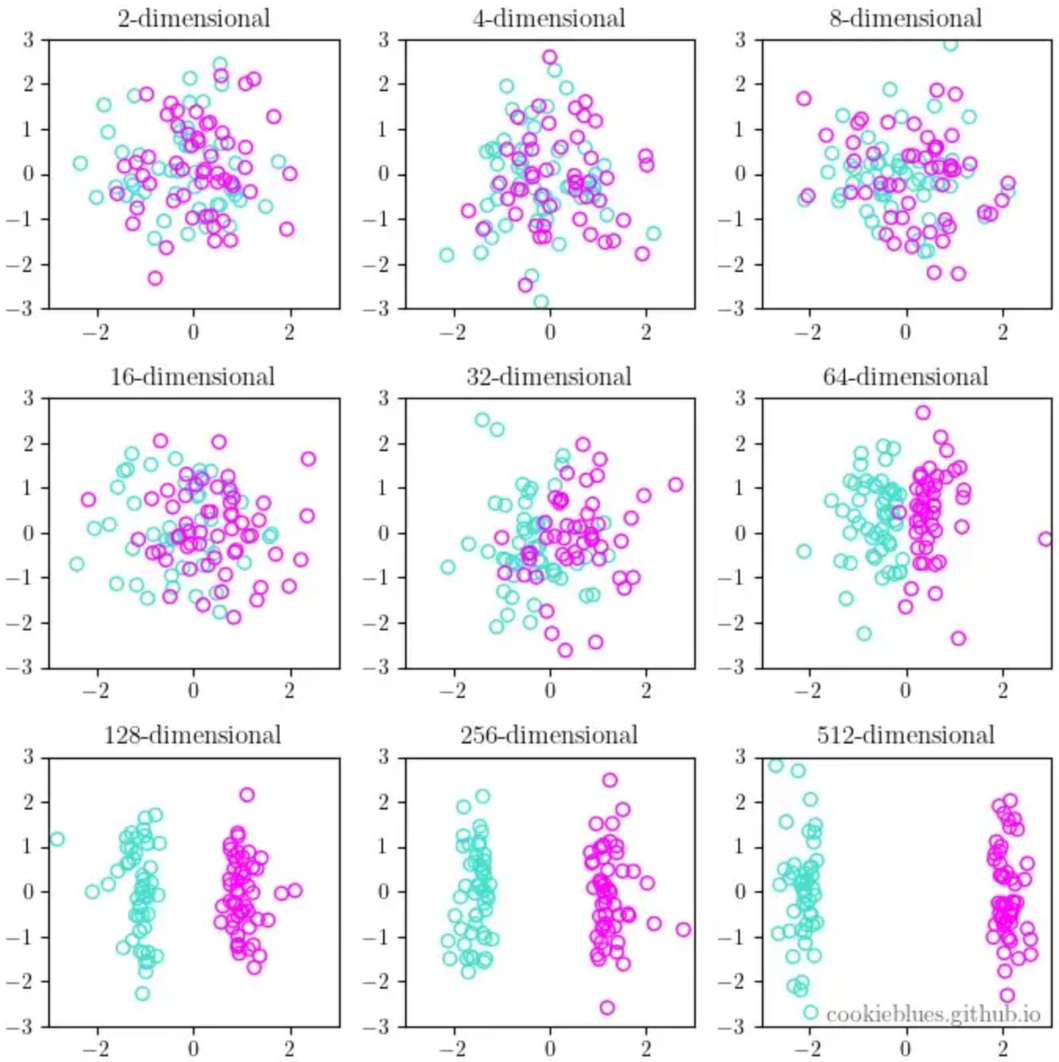


Illustration of the curse of dimensionality.

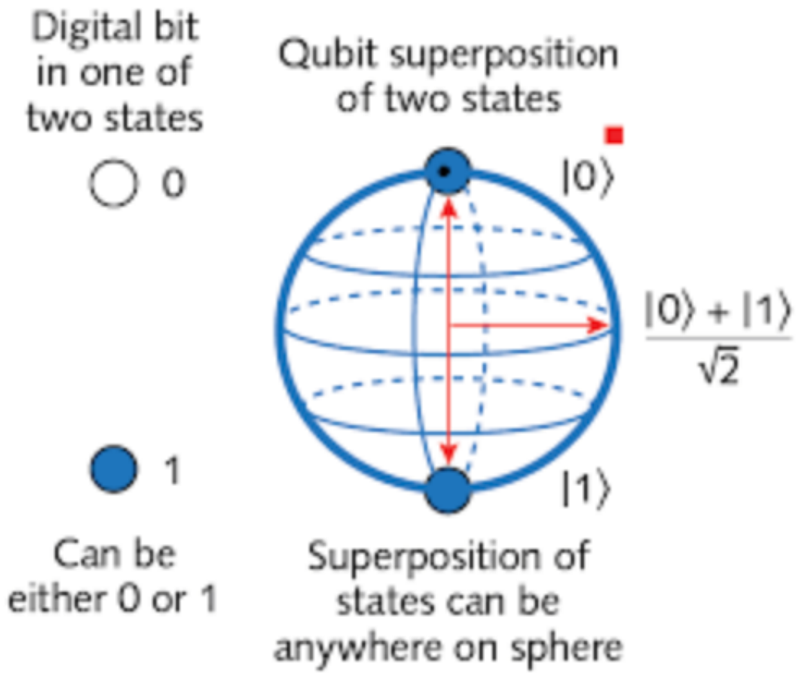
Source: https://towardsdatascience.com/the-curse-of-dimensionality-5673118fe6d2

Litrature Survey

- Several algorithms for classification it is considered that SVM and KNN besides Random Forest are the best performings.
- It is observed that Quantum enhanced SVM performed better than classical ML SVM. A possible limitation on QSVM is discussed regarding the implementation of kernel models as it would be complex to implement using Quantum circuits for Radial basis kernel.

Solution:

- Using Quantum Mechanics properties like superposition and entanglement we can enhance our tradition ML algorithms to perform better with high dimensionality
- Increase storage capacity and speed exponentially.
- With only 275 qbits we can represent 2^ 275 more states than the number of atoms in the observable universe.

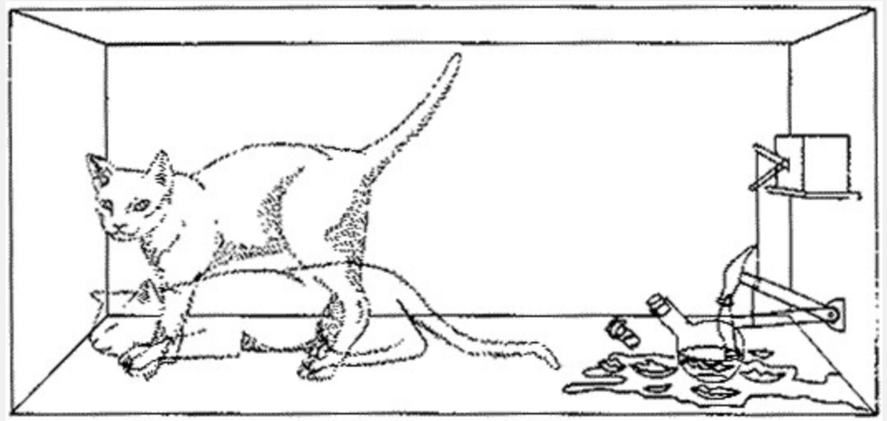


Source: https://dev.to/ucscmozilla/quantum-computing-explanation-and-its-evolution-2ch8

Quantum Terminologies:

Superposition:

A qbit can be in any state between 1 and 0 at any given point, this property is called superposition of qbits.

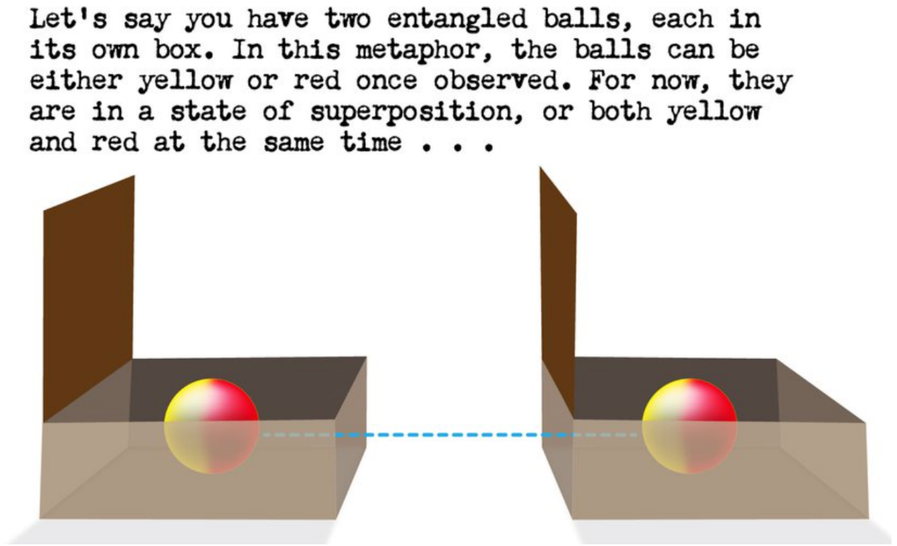


Schrödinger proposed this thought-experiment to demonstrate how ridiculous quantum superposition is. Basically the multiple states of a single atom (decayed and not decayed) causes a cat to be in multiple states (living and dead).

Source: https://www.askamathematician.com/2013/04/q-why-is-schrodingers-cat-both-dead-and-alive-is-this-not-a-paradox/

Entanglement:

Any two bits do not occur individually but are inseparable whole. We cannot only change 1 bit we need to consider a pair.



Source: https://scienceexchange.caltech.edu/topics/quantum-science-explained/entanglement

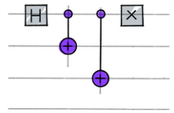
IBM Quantum Simulator

Qiskit/**qiskit-machine-learning**

Quantum Machine Learning

57 Contributors | 86 Used by | 349 Stars | 226 Forks

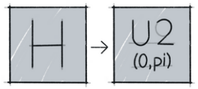
What Can Qiskit Do



Circuit Library

Qiskit includes a comprehensive set of quantum gates and a variety of pre-built circuits so users at all levels can use Qiskit for research and application development.

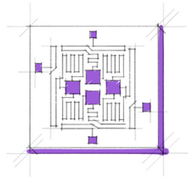
Learn more



Transpiler

The transpiler translates Qiskit code into an optimized circuit using a backend's native gate set, allowing users to program for any quantum processor or processor architecture with minimal inputs.

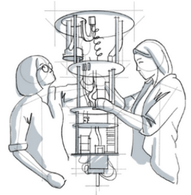
Learn more



Run on real hardware

Users can run and schedule jobs on real quantum processors, and employ Qiskit Runtime to orchestrate quantum programs on cloud-based CPUs, QPUs, and GPUs.

Learn more

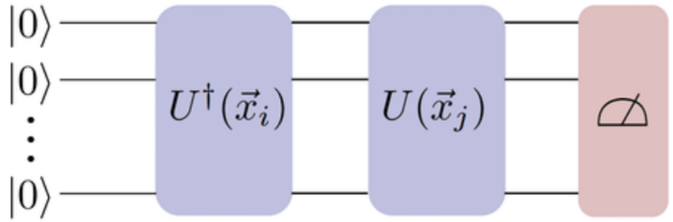


Try it yourself

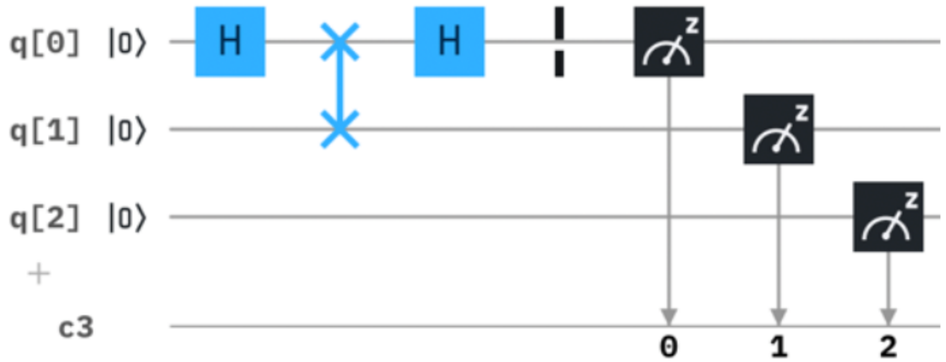
Ready to explore Qiskit's capabilities for yourself? Copy the code to the right of this paragraph and try running it in your local Python environment. You can also click the link to the IBM Quantum Lab and test it there.

Model

Quantum Support Vector



$$\Rightarrow K_{ij} = |\langle 0|U^\dagger(\vec{x}_i)U(\vec{x}_j)|0\rangle|^2$$



Algorithm 1 QSVM Pseudo code for featuremap selection

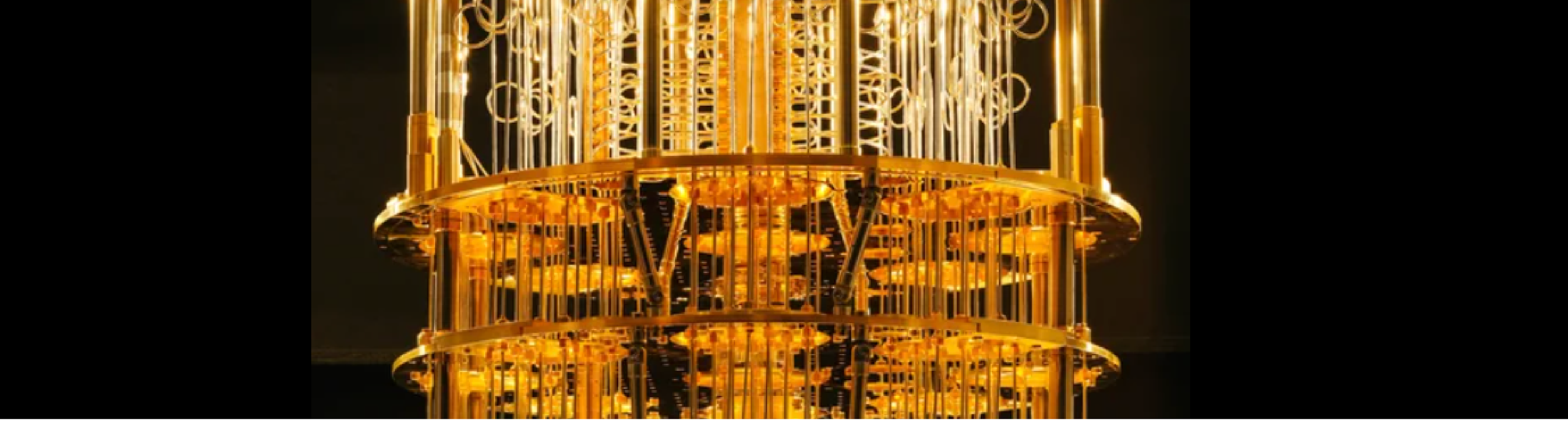
Input: Select training samples $(\vec{x}_i, y_i) : \vec{x}_i \in R^N, y_i = \pm 1_{i=1,2,3...n}$
Output: Best fit feature map selection

Parameters: Train and test sample, featuremap, repetitions(reps), entanglement, multiclass
while $reps = 1 \Leftarrow n$ **do**
  for $Pauli\_list = 1 \Leftarrow 10$ **do**
    $U_\Phi(\vec{x}) = exp(i\sum_{j=1}^{n} \alpha_j \phi_s(\vec{x}) \Pi \sigma_j \in \{I, X, Y, Z\})$
      Record measurement through ancilla register
  end for
end while

Demo Time!

Summary

- The conclusions should only be regarded with a grain of salt because these results were computed on a small dataset with n = 10 dimensions and were somewhat random.
- When quantum computing becomes more widely available, we might need to perform a cost analysis to determine whether the advantage is worthwhile or not. Physical quantum computers are now only available to academics and collaborators at accredited institutions, not to the general public.
- As a result of the notion of an improved quantum feature space, machine learning can thus benefit from quantum computing.



THANK YOU FOR YOUR ATTENTION