Qiskit Fall fest
Quantum Convolutions for lungs segmentation

Qnow - QML

Oct 2024

Agenda

- Introduction
  - Data set
- Neural networks.
  - Convolutional neural networks
  - U-net
  - Metrics
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  - Quanvolution - QCNN
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  - Results new data
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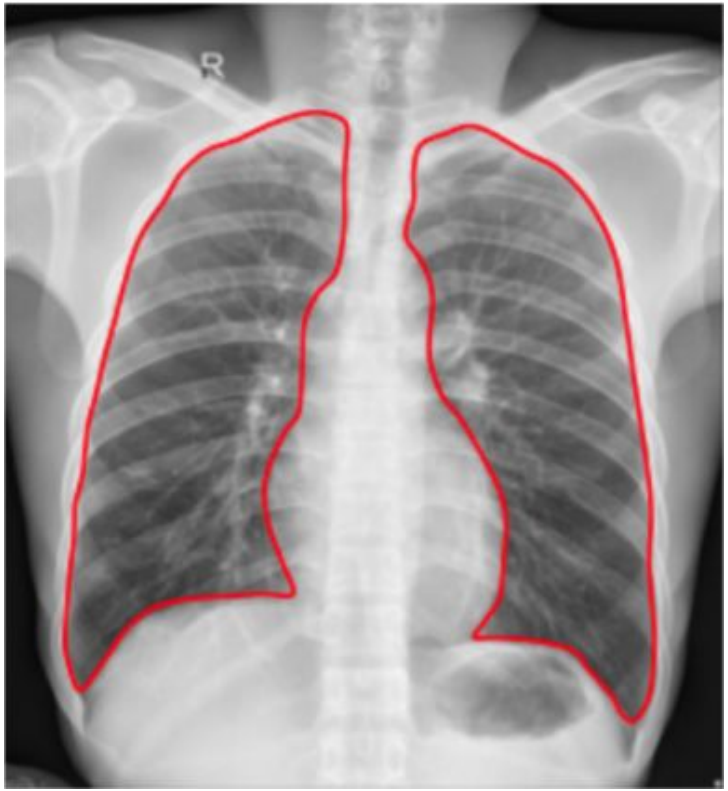
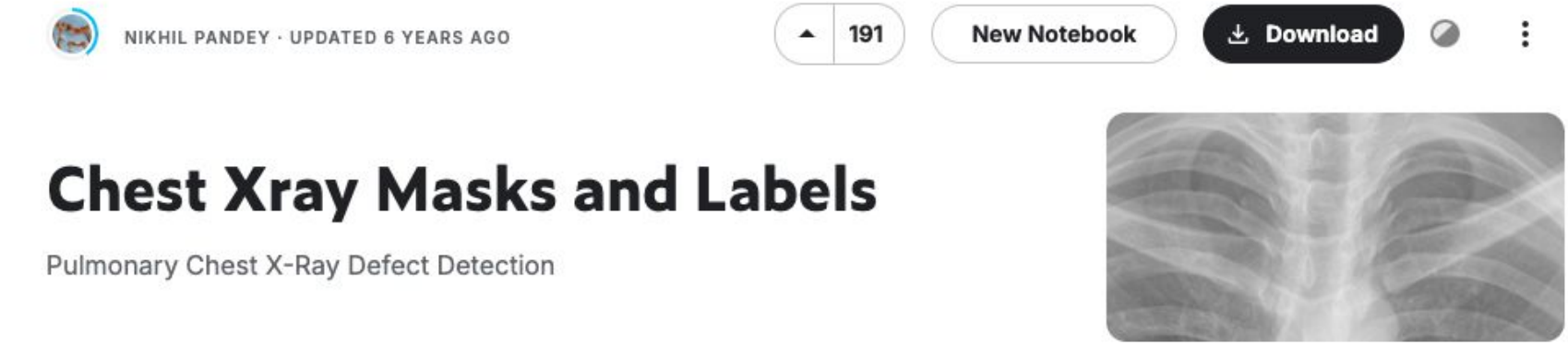
Introduction

Lung segmentation in X-ray images, with a focus on data preprocessing for the training of a classical model using a QNN.

The process of segmentation and context in images is currently done efficiently by a classic U-net type architecture model with convolutional neural networks.



Dataset

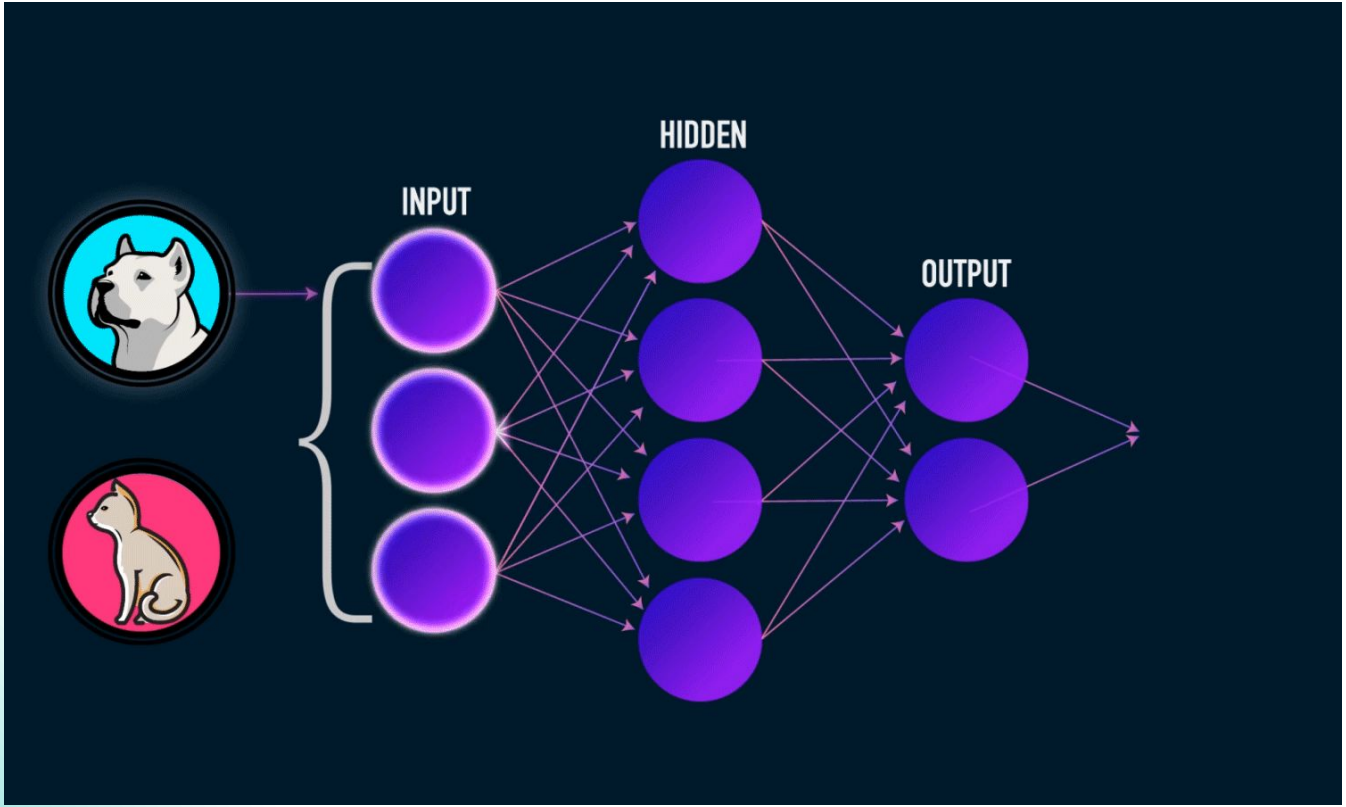


kaggle

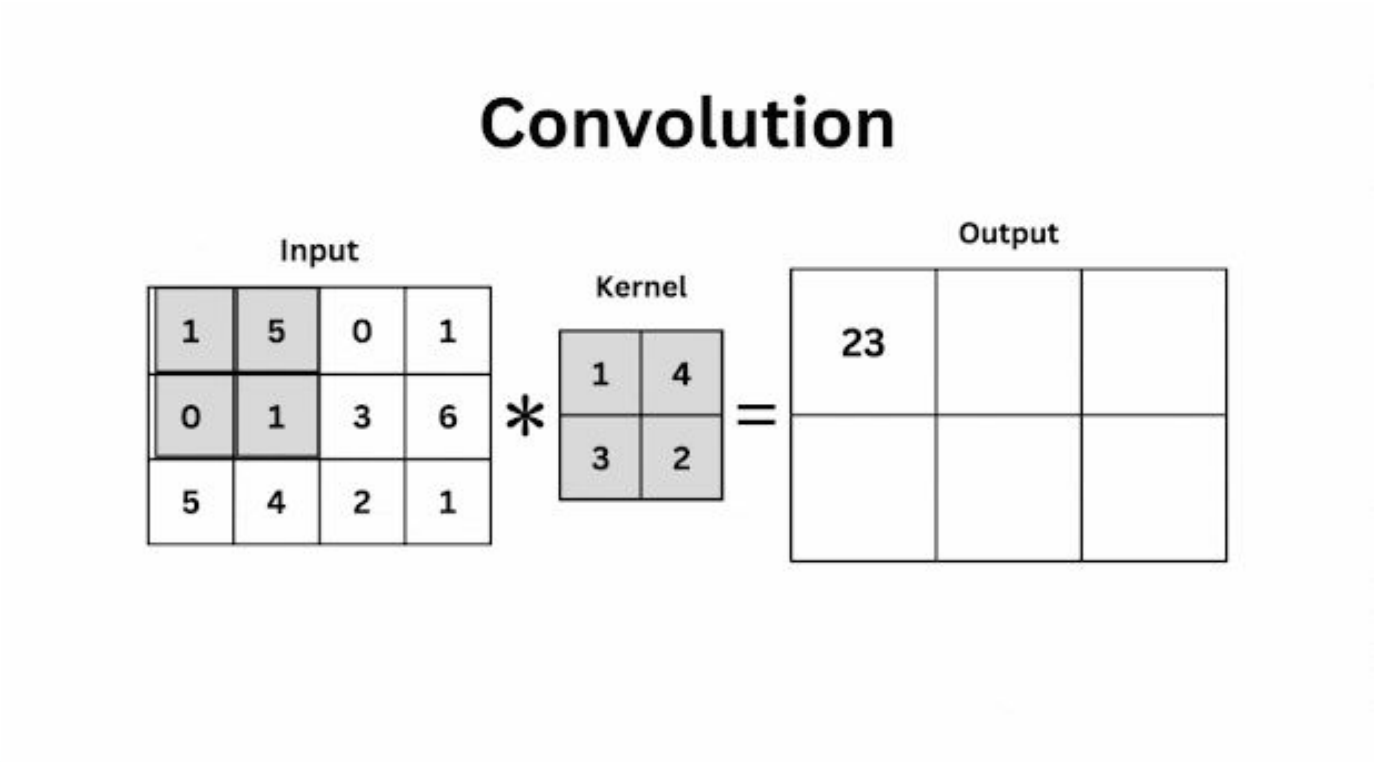
[Notebook]

[Data]

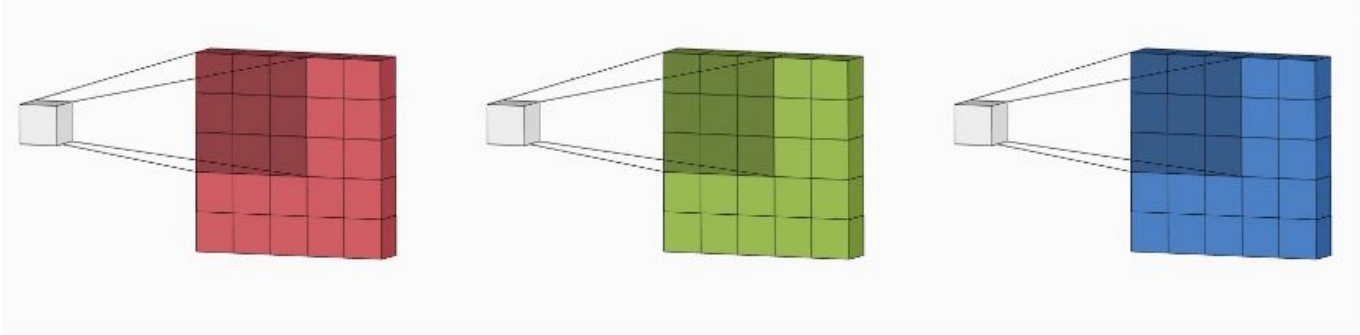
Neural networks



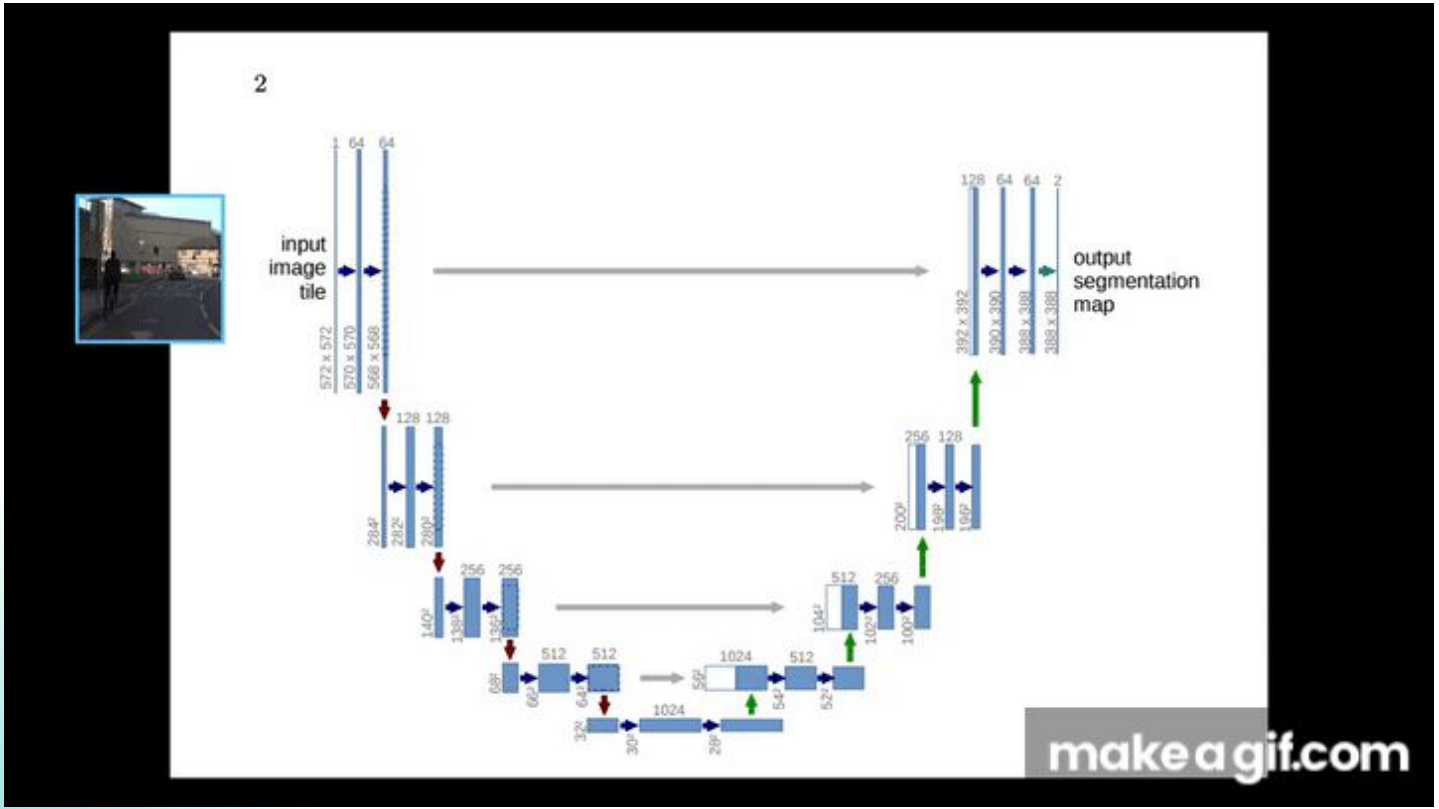
Convolutional Neural Networks - CNN



RGB



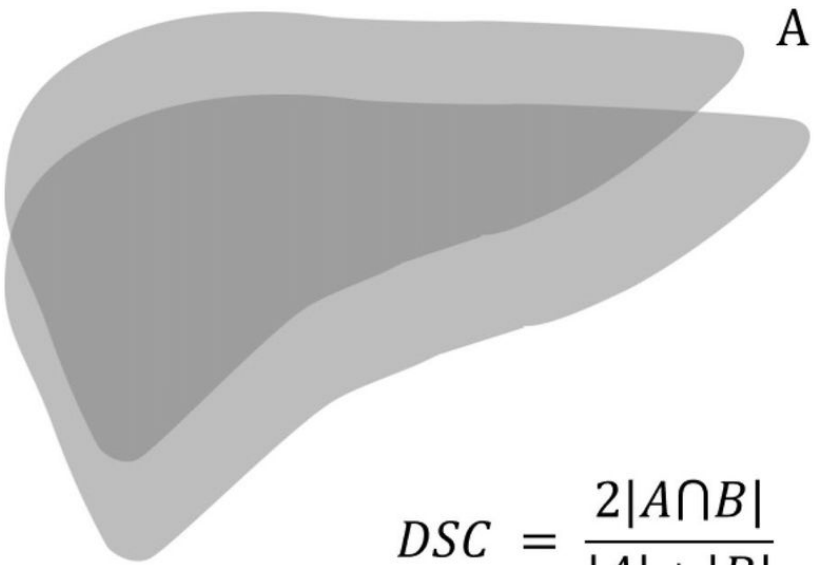
U-net



Metrics - Dice

The Dice coefficient is a statistic used to measure the similarity of two samples, one of the most used metrics in the context of image segmentation.

0% - 100%



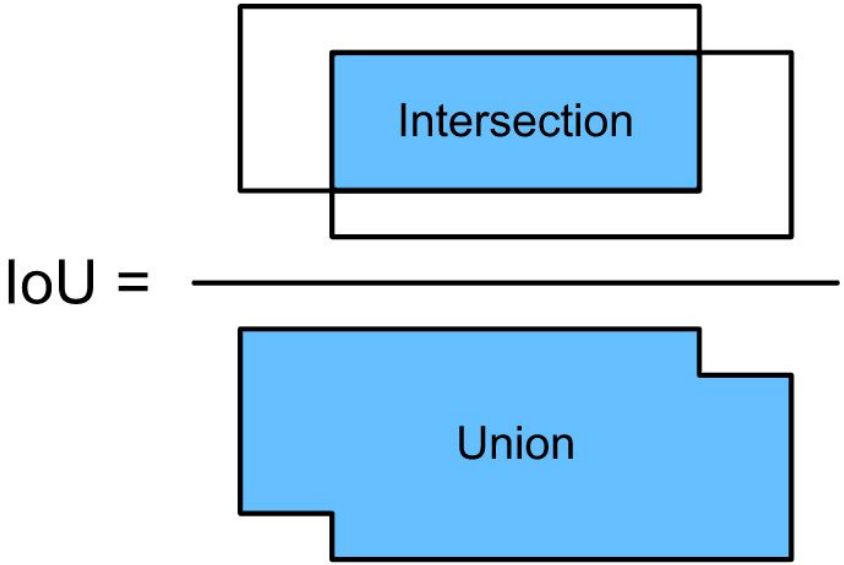
$$DSC = \frac{2|A \cap B|}{|A| + |B|}$$

DSC: Dice similarity coefficient

Metrics - IoU

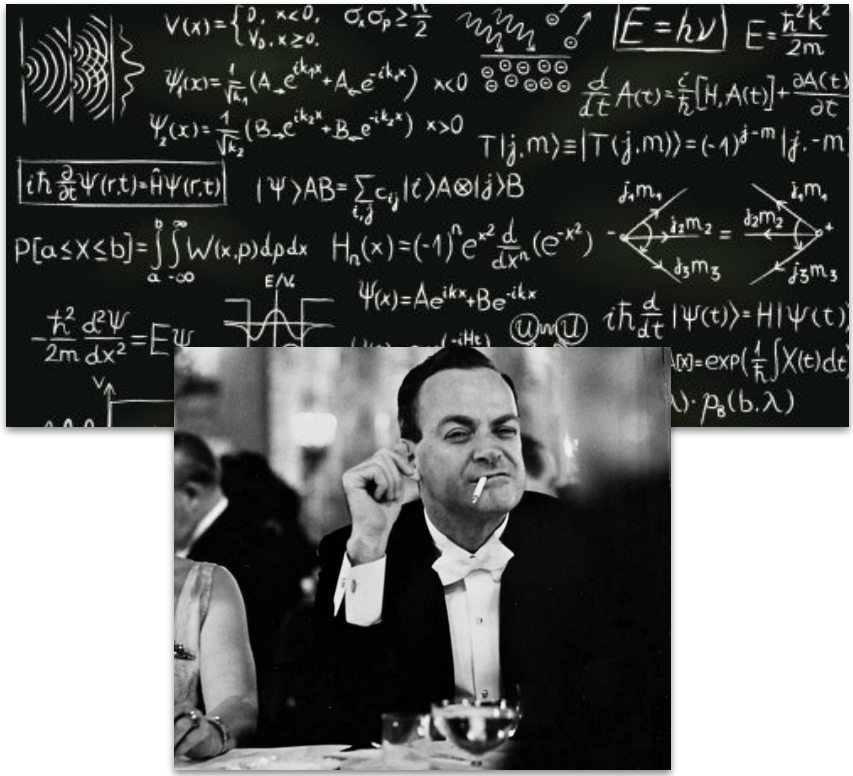
Is a performance metric used to evaluate the accuracy of annotation, segmentation, and object detection algorithms.

0% - 100%

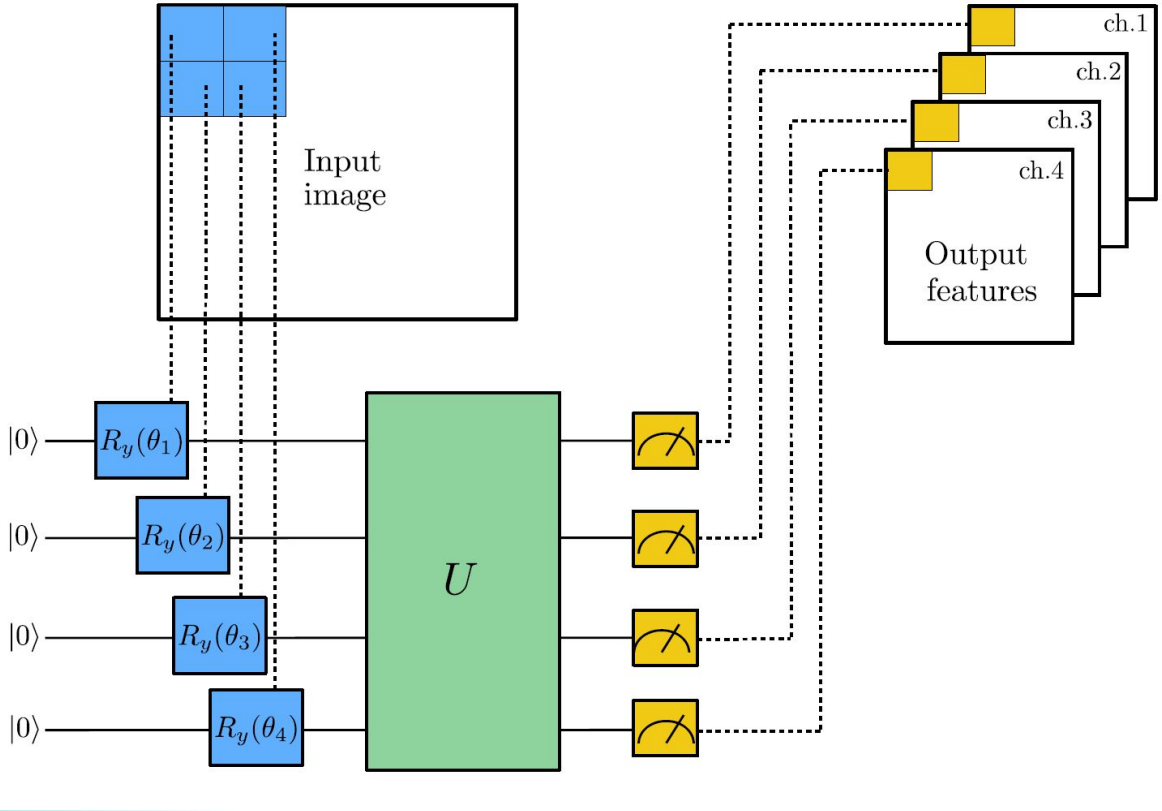


Quantum Computing

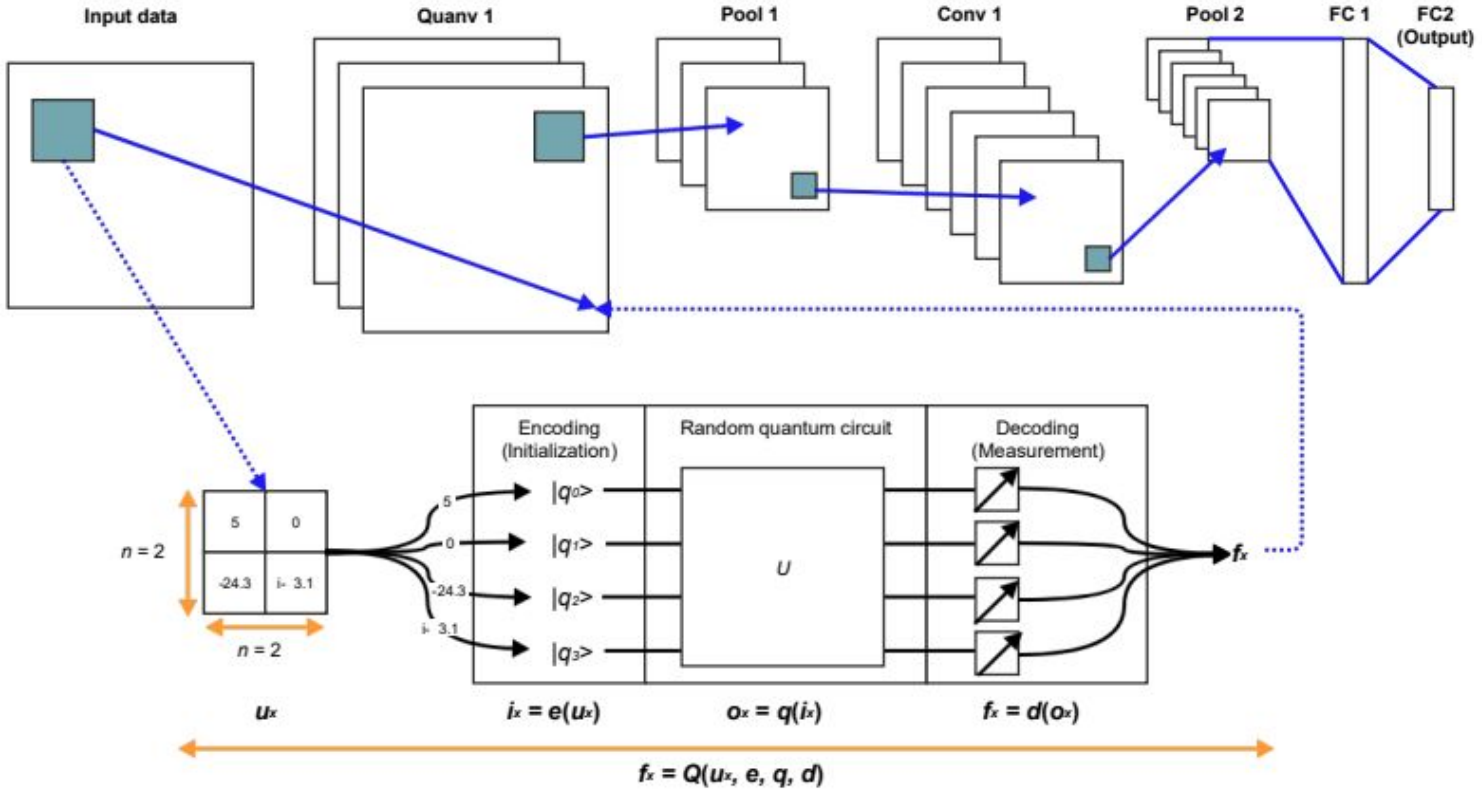
It combines the phenomena of quantum physics, information theory and computer science. It is based on the use of qubits, which is the basic unit of quantum information.



Variational Quantum Algorithms

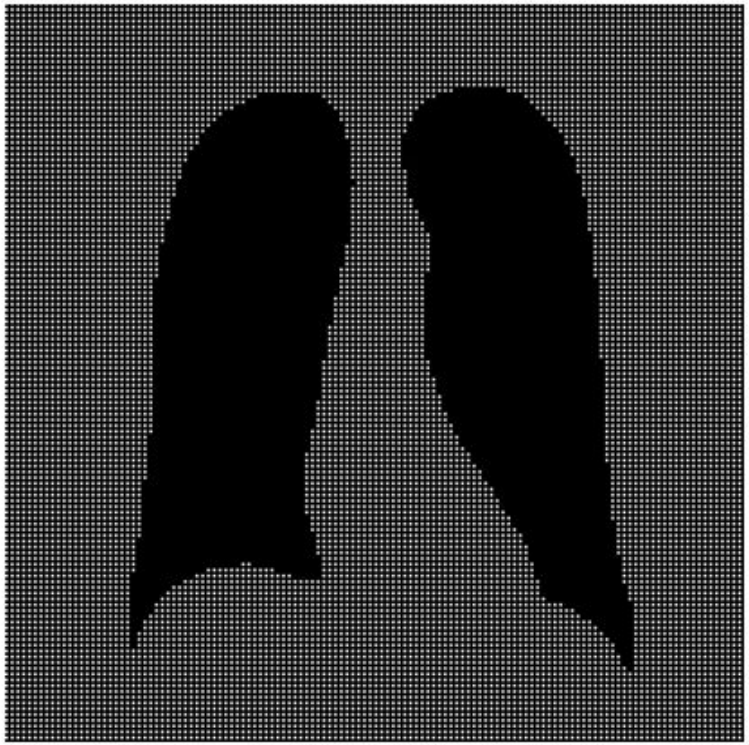


Quavolution - QNN

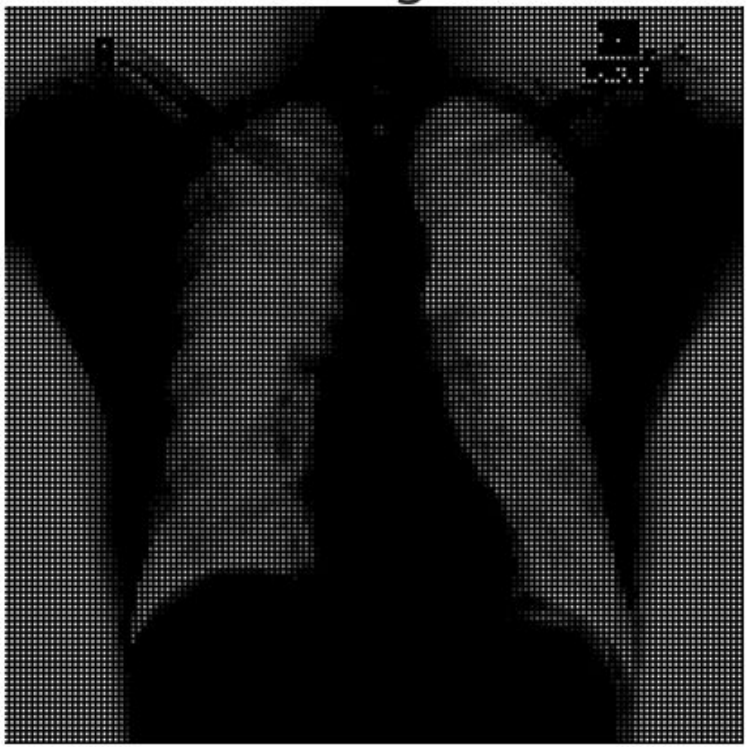


X-ray images

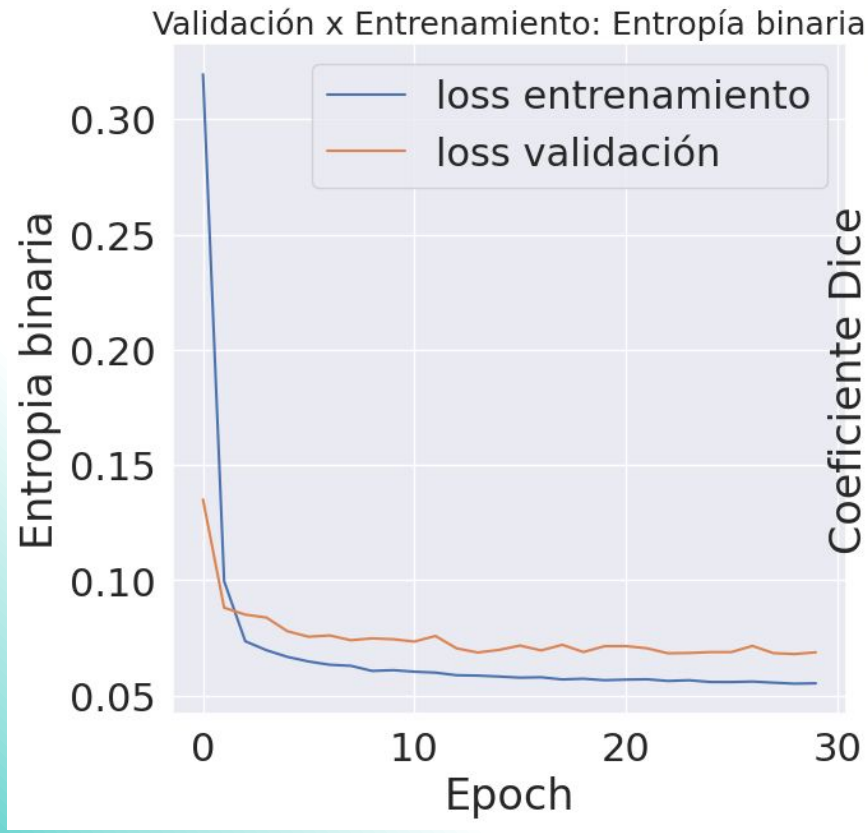
Mask

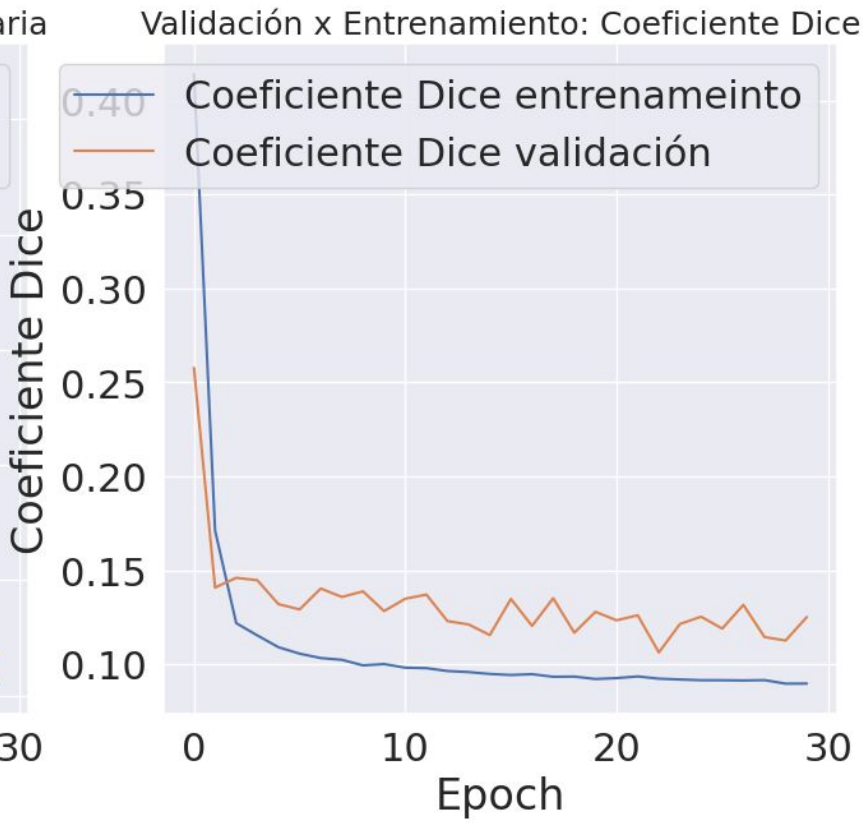


Image

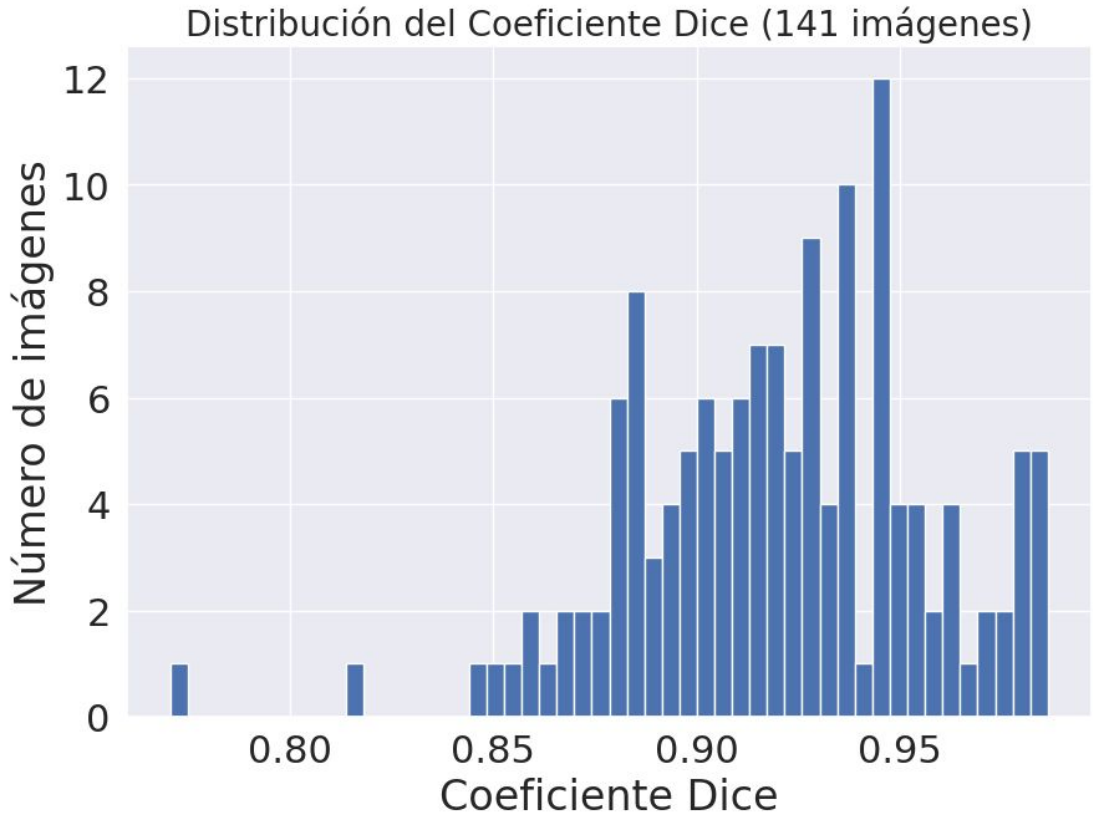


Metrics


Validación x Entrenamiento: Entropía binaria
loss entrenamiento
loss validación
Entropia binaria
0.30
0.25
0.20
0.15
0.10
0.05
0
10
20
30
Epoch

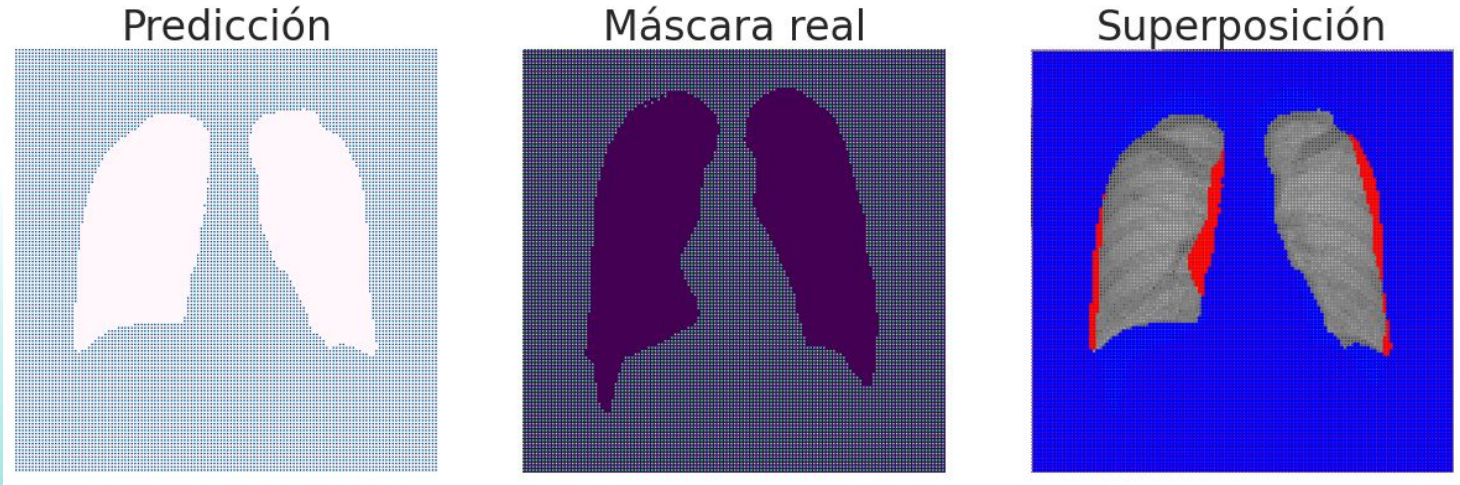

Validación x Entrenamiento: Coeficiente Dice
Coeficiente Dice entrenameinto
Coeficiente Dice validación
Coeficiente Dice
0.40
0.35
0.30
0.25
0.20
0.15
0.10
0
10
20
30
Epoch

Results test data

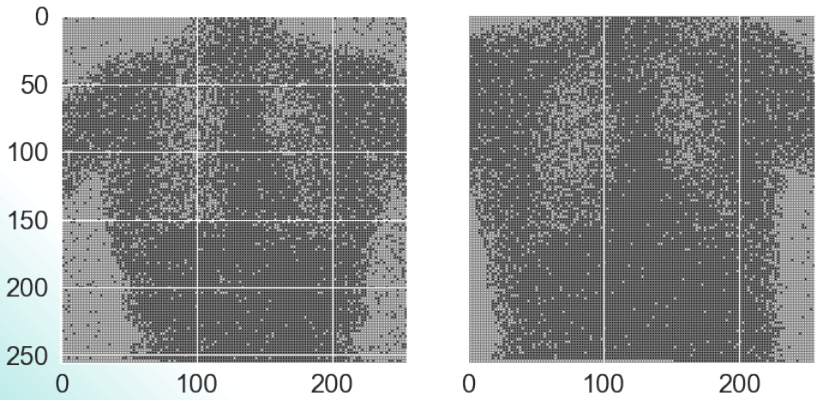


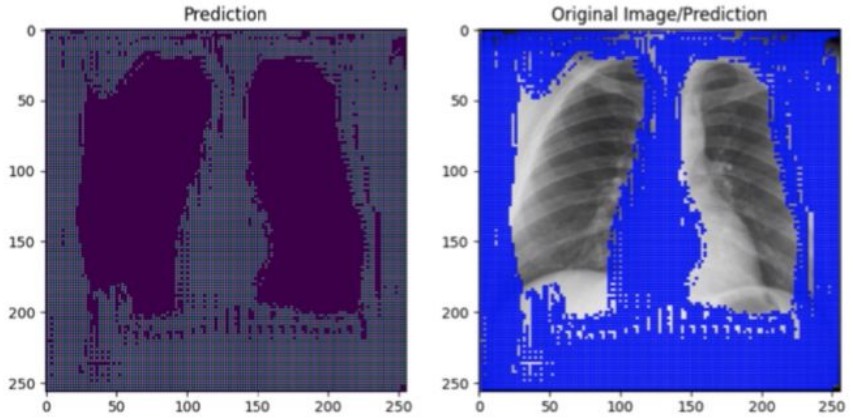
Dice - IoU

Dice: 94.45% and IOU: 89.48%

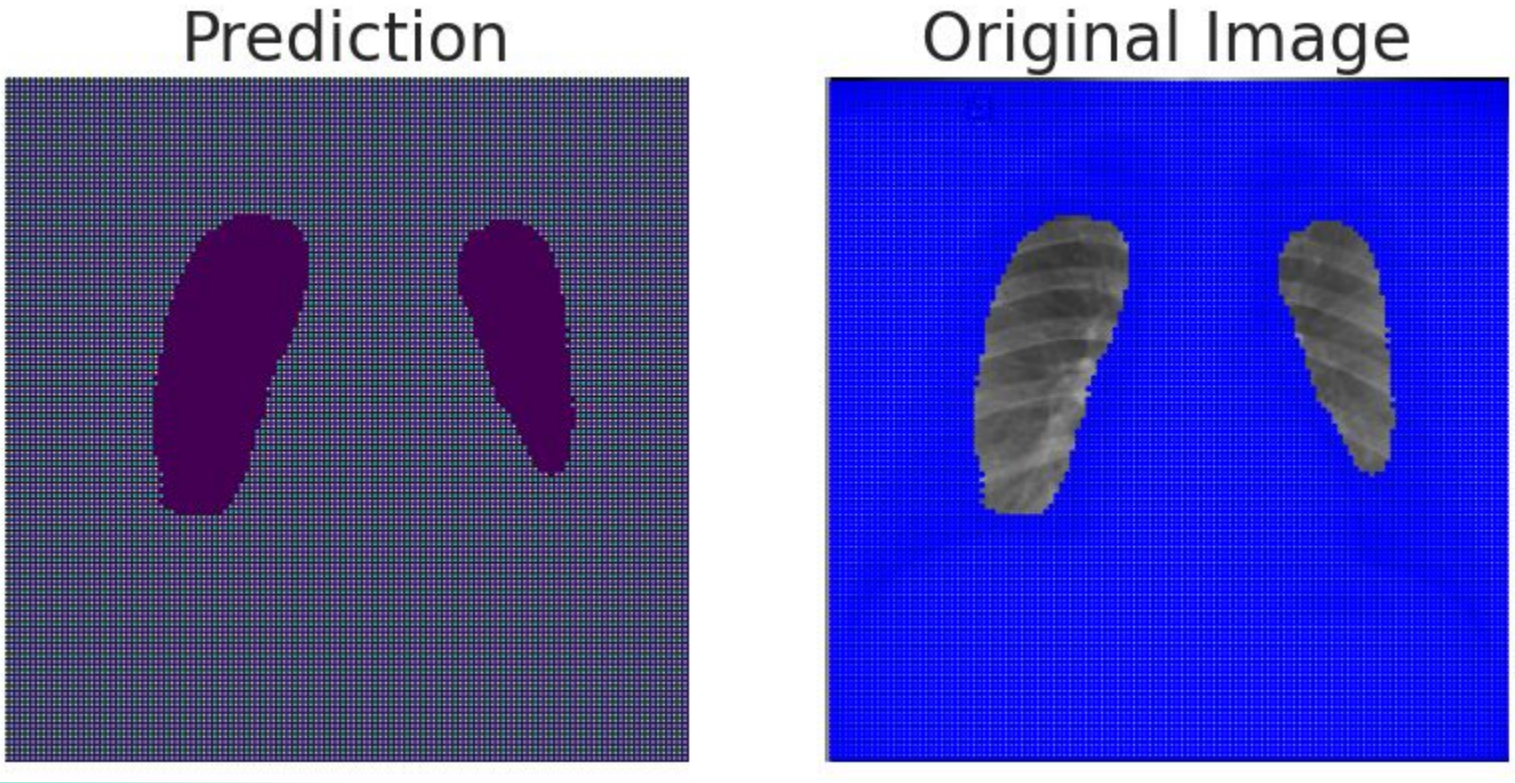


Results new data - 1 shot

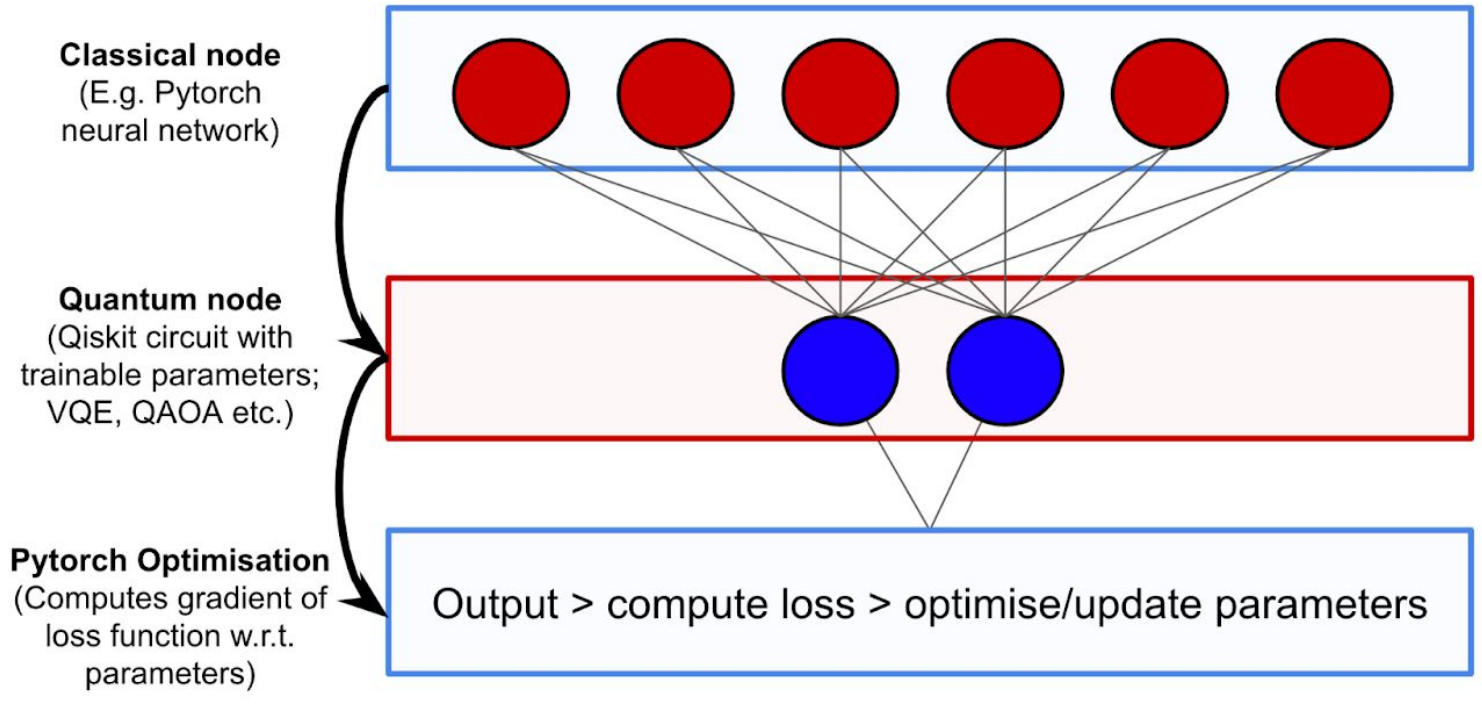




Results new data – 1024 shots



Challenges

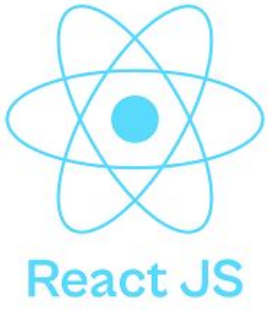

Classical node
(E.g. Pytorch neural network)
Quantum node
(Qiskit circuit with trainable parameters; VQE, QAOA etc.)
Pytorch Optimisation
(Computes gradient of loss function w.r.t. parameters)
Output > compute loss > optimise/update parameters

Challenges

In advance of this first approach and evolution of the research, it is necessary:

- preprocess the data on a real quantum computer using 4 qubits or more so that the results can be analyzed with a real quantum computer.
- Use the same approach with other types of quantum hardware such as: ion trap or photons.
- Evolve this approach and connect the result of this segmentation model with other models for inference in lung cancer detection.

Tools



Q&A

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Thanks!

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