Seminar Presentation

Research Center for Technology and Art

ARS Electronica Festival 2021 - Garden Hsinchu / Taipei

The “ Entrance and Distancing ” Deals in the Digital Era

“ Medium . Permeation “

– AI Art Project

Key word: Covid19, Deep Learning

Reporter: IPHD, YuanFu Yang

https://techart-ars.tw/2021/?page_id=293

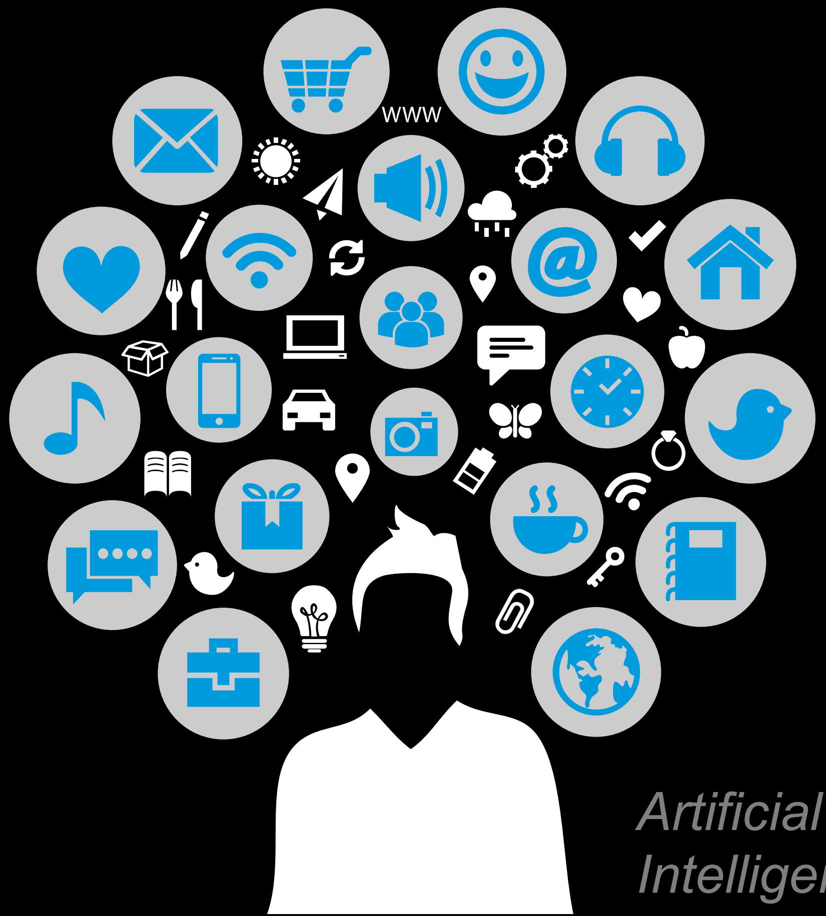
https://github.com/Yfyangd/Ars-Electronica-2021

01 Background

02 Art Statement

03 Method

04 Connection

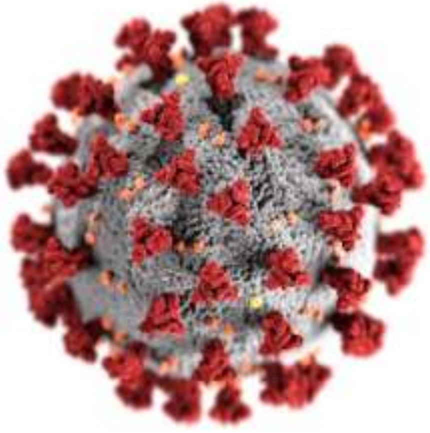


Artificial Intelligence Art

How to Draw the Coronavirus

《The Paris Review》

-Rebekah Frumkin



create an arresting visual

gave a certain "character" to the disease

"It just really stood out."

"We didn't want to scare the public,"
"but we did want them to take it seriously."

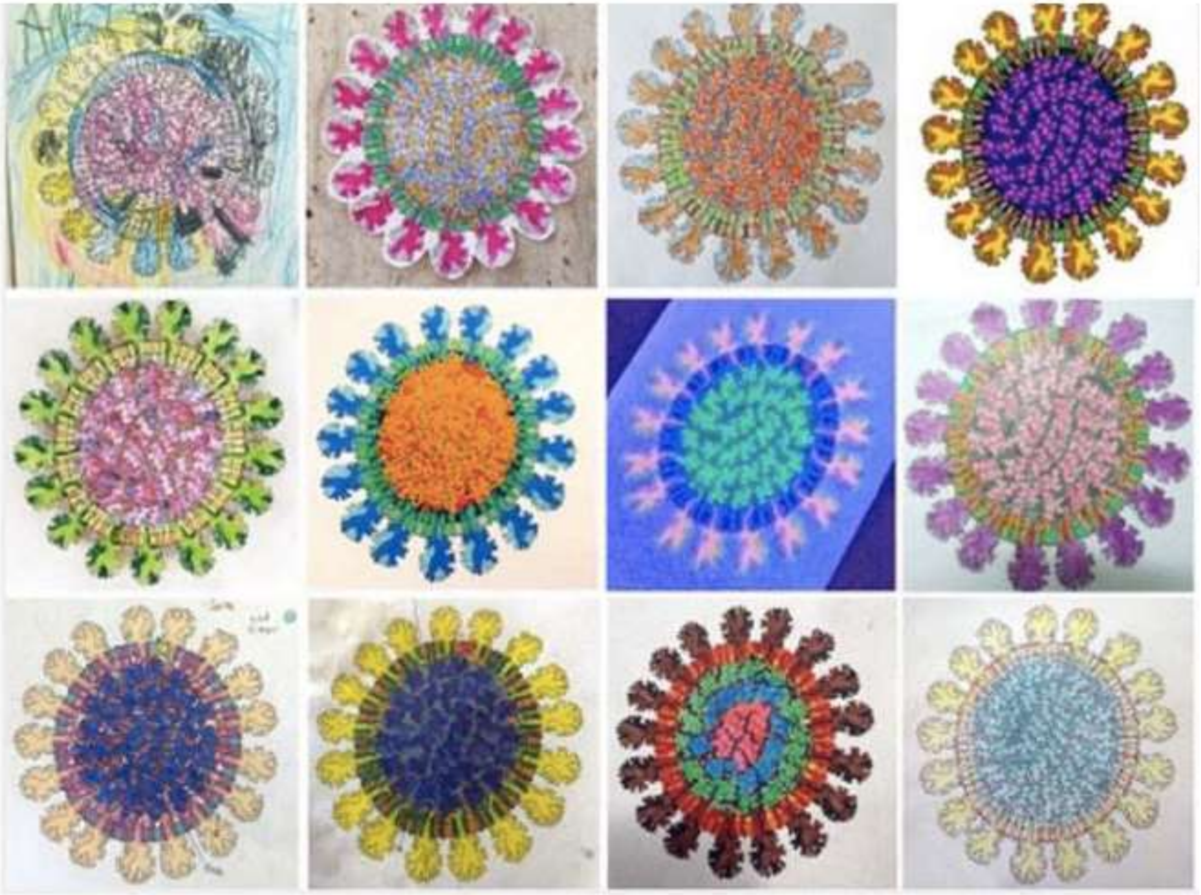
"Their illustration kind of looks handsome."

"It has a certain symmetry to it,
an appealing design."

趙佳禾 2021.6.15

Seminar Presentation

Research Center for Technology and Art



SELECTIONS FROM DAVID GOODSELL'S CORONAVIRUS ONLINE COLORING ACTIVITY

Authors

YuanFu Yang (楊元福)

International collegiate PHD program student in National Tsing Hua University, TW.

Data Scientist / tsmc

Yang is the Ph.D. student at National Tsing Hua University for his research on Artificial Intelligence (AI) to enhance human creativity. He joined Taiwan Semiconductor Manufacturing Company in 2006. Yang conducts research and production across fields such as defect inspection and yield prediction using deep learning techniques. Yang, himself, has been exploring the potential expansion of painting creativity through the AI and human experts.

Iuan Kai Fang (房元凱)

International collegiate PHD program student in National Tsing Hua University, TW.

Master degree in lighting design from Parsons School of Design, NY. The other’s in interior design from Chung Yuan University, TW.

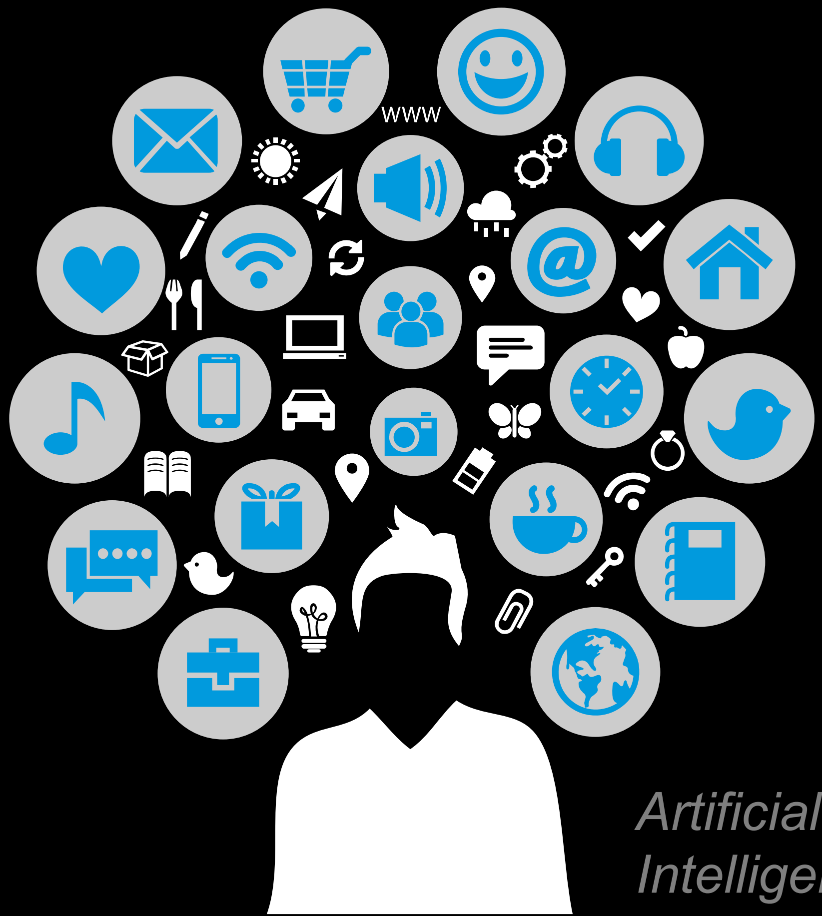
He has been engaged in interior design for nearly 20 years. His works have won numerous awards including Red Dot ,IF,etc. However, he just started to touch the field of AI Art . Currently, he is studying the technology of 2D single image automatic generates to a 3D model.

01 Background

02 Art Statement

03 Method

04 Connection



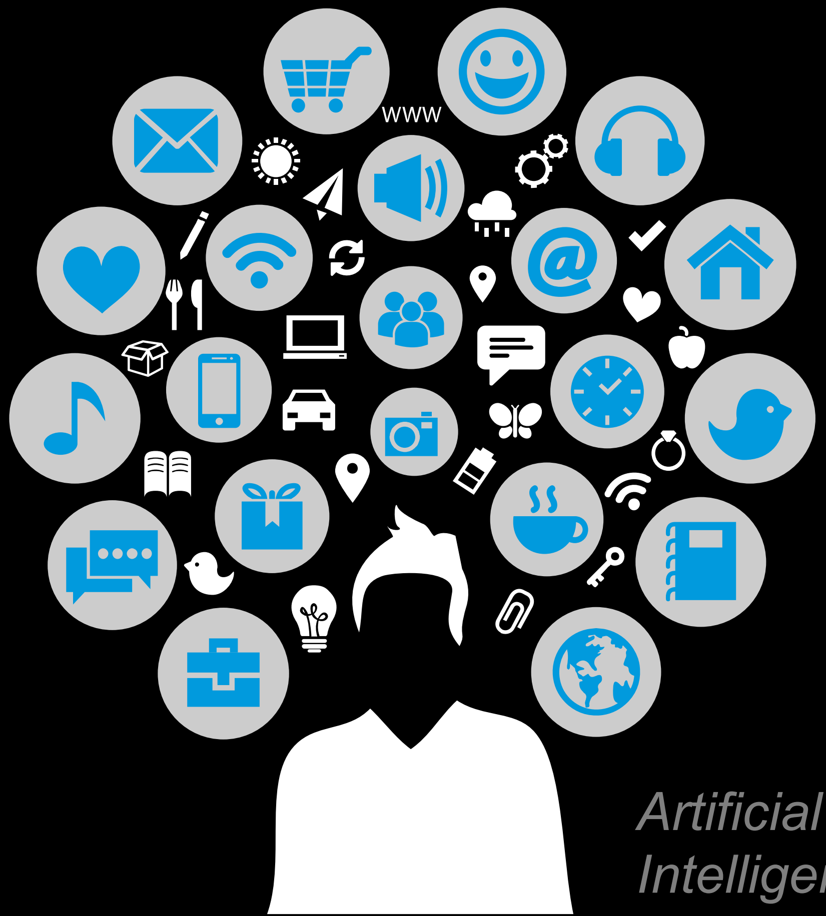
Artificial Intelligence Art

01 Background

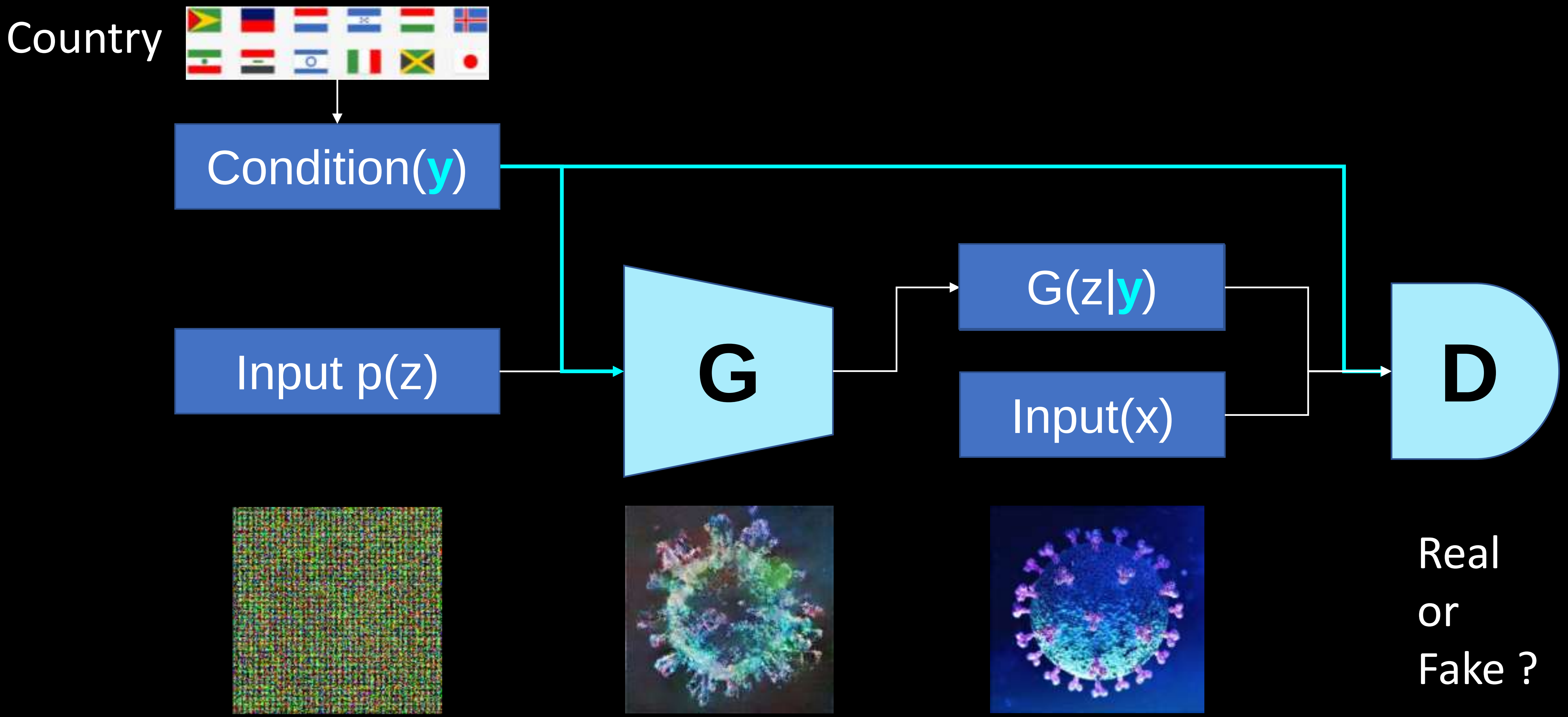
02 Art Statement

03 Method

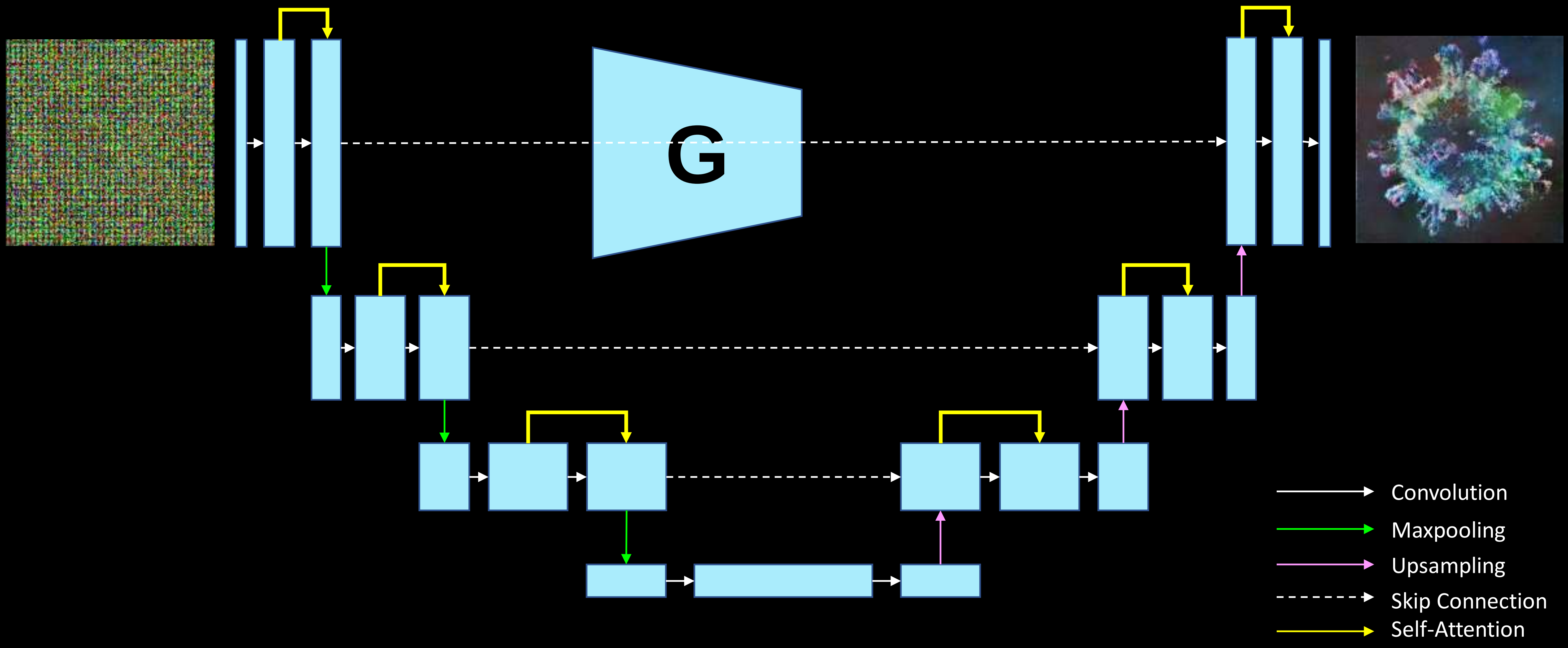
04 Connection

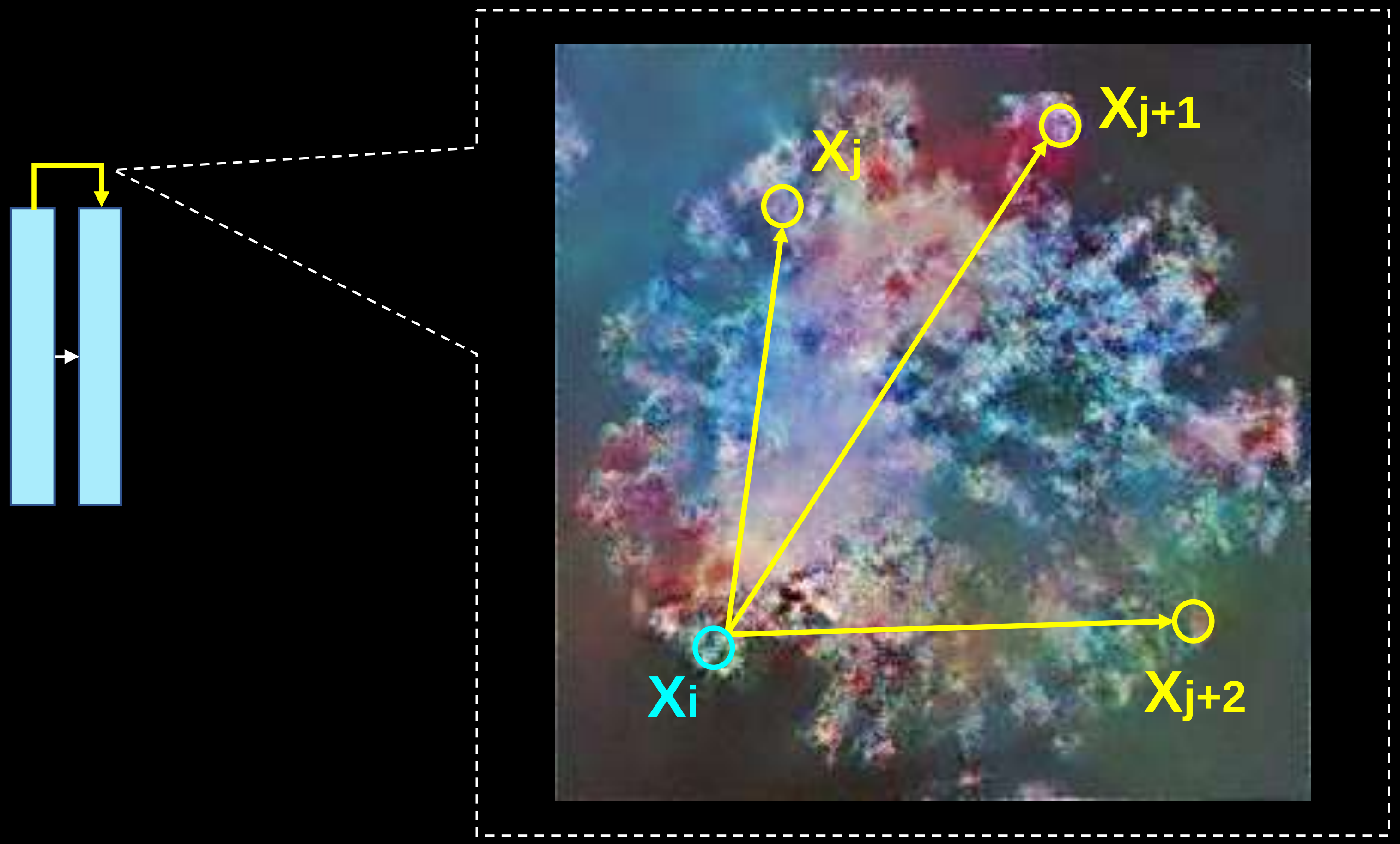


Artificial Intelligence Art



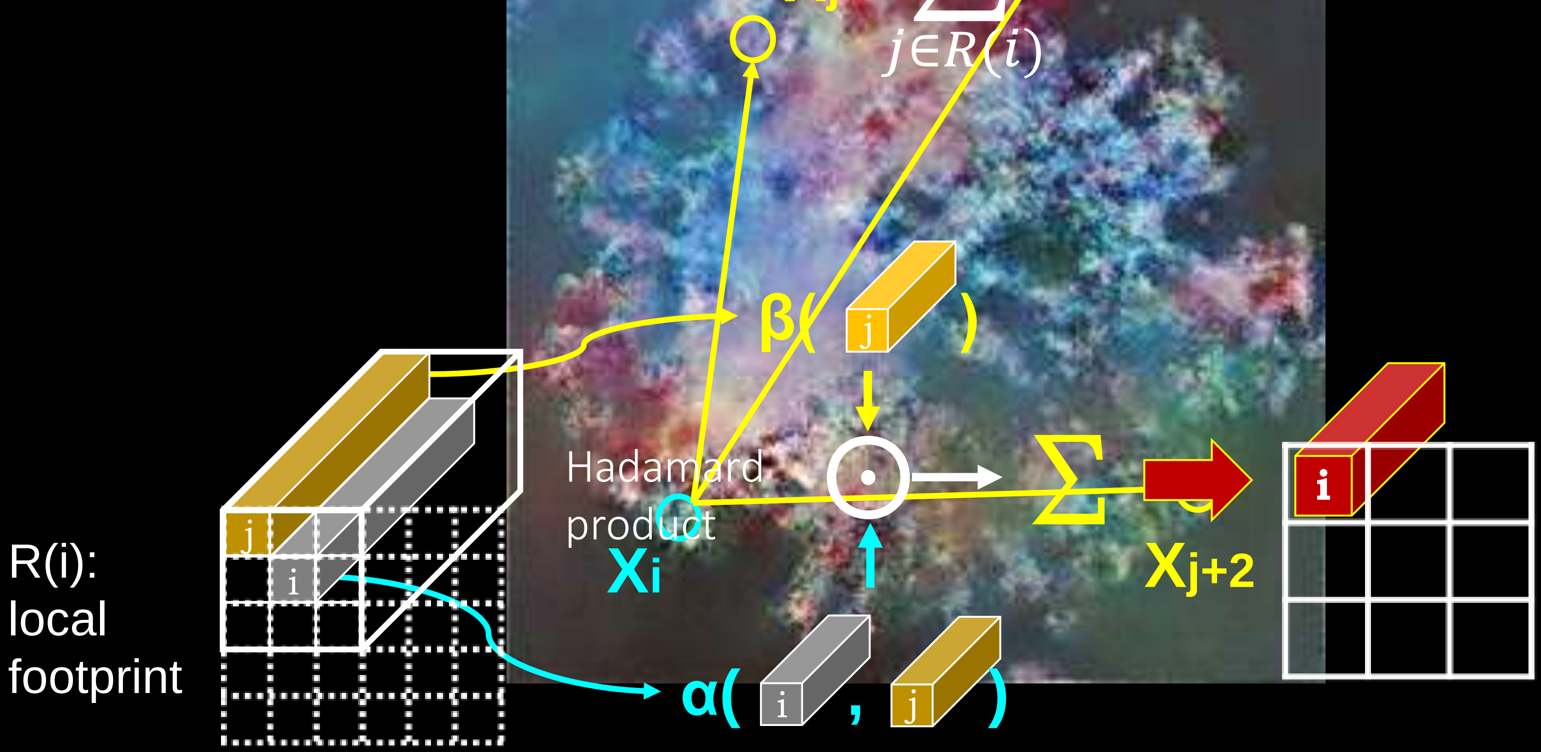
$$\min_G \max_D V(D,G) = \mathbb{E}_x[\log D(x|y)] + \mathbb{E}_z[\log(1 - D(G(z|y)))]$$


G
Convolution
Maxpooling
Upsampling
Skip Connection
Self-Attention



Xj
Xj+1
Xi
Xj+2

$$m_i = \sum_{j \in R(i)} \alpha(x_i, x_j) \odot \beta(x_j)$$

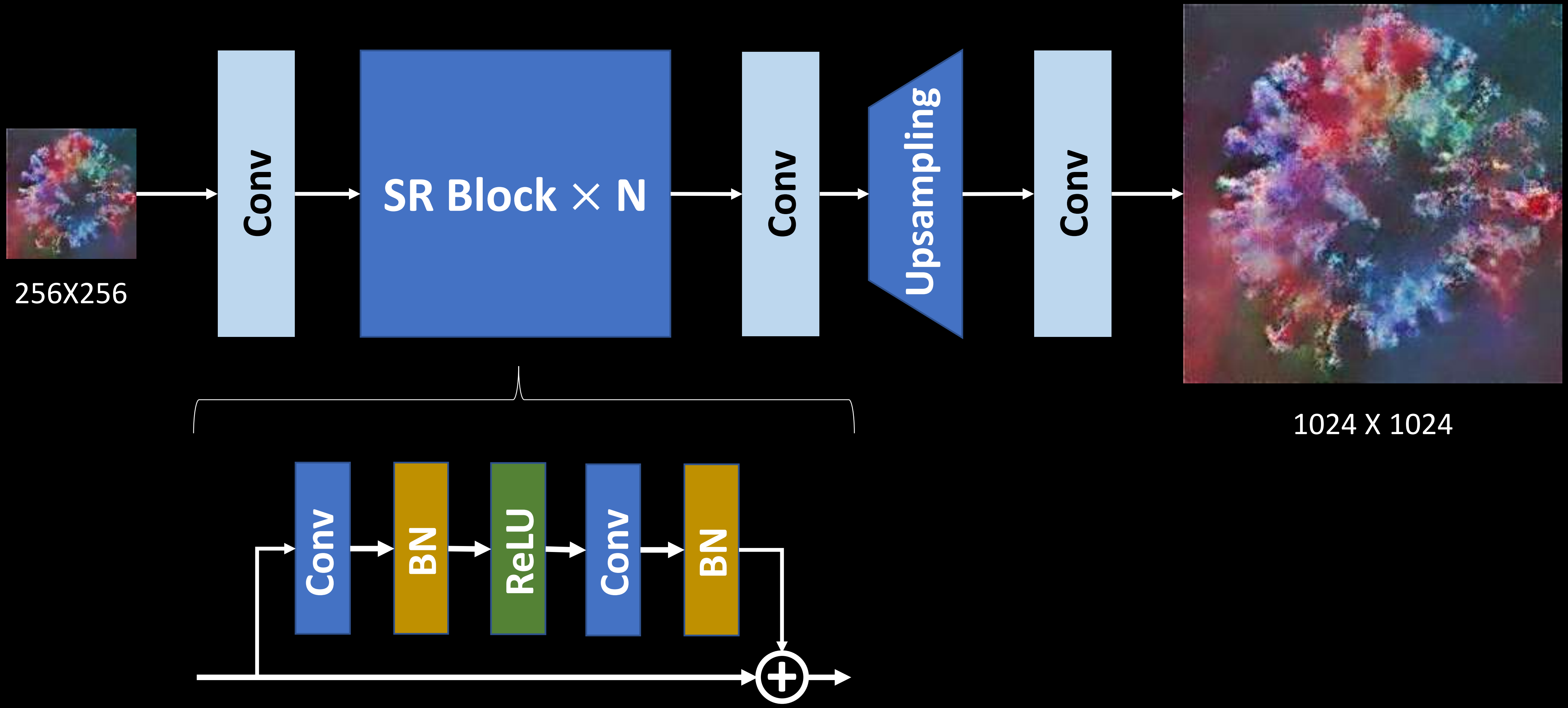


x_i: old feature

Aggregating by $\alpha(x_i, x_j)$

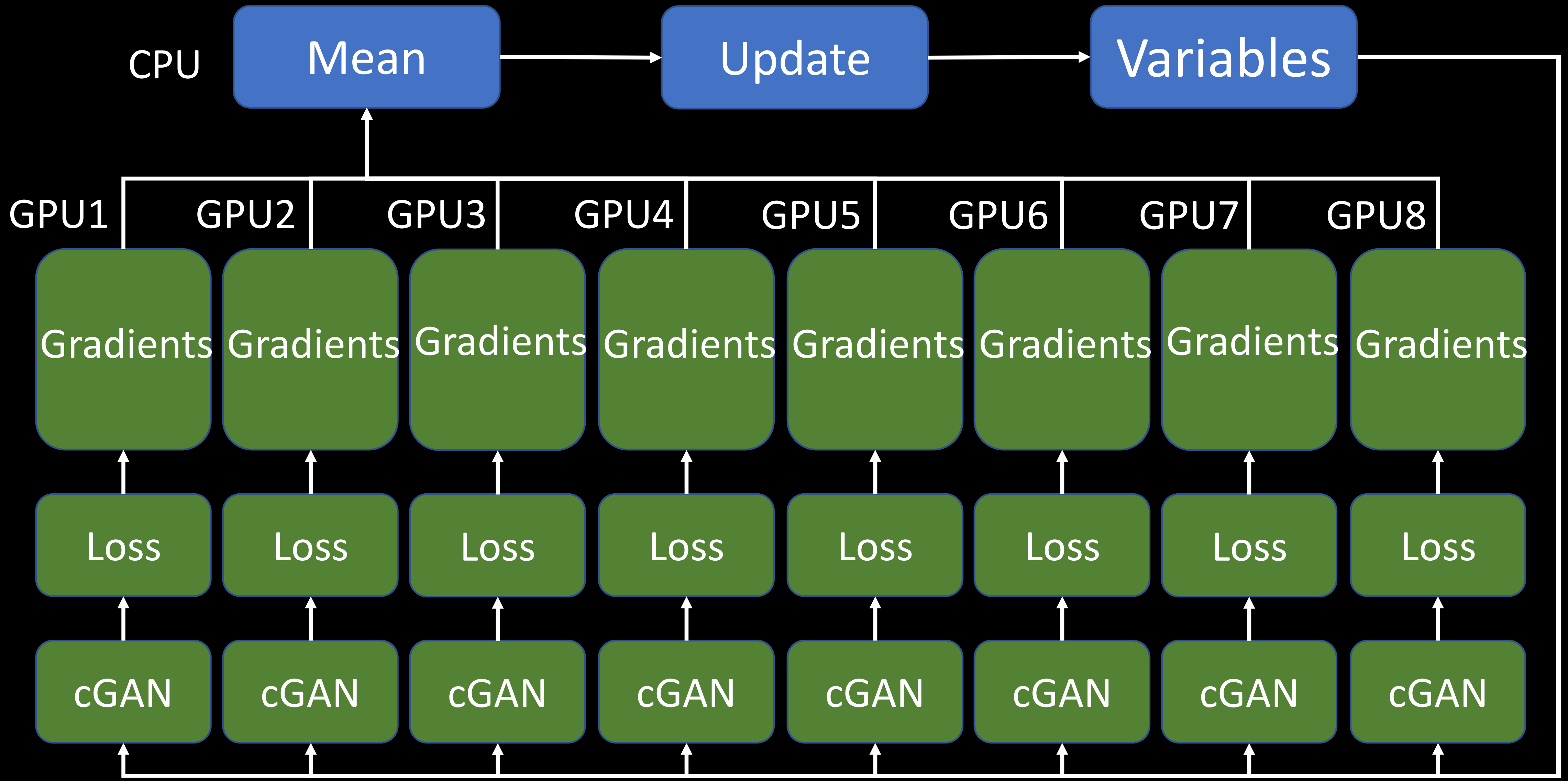
m_i:new feature

Super-Resolution

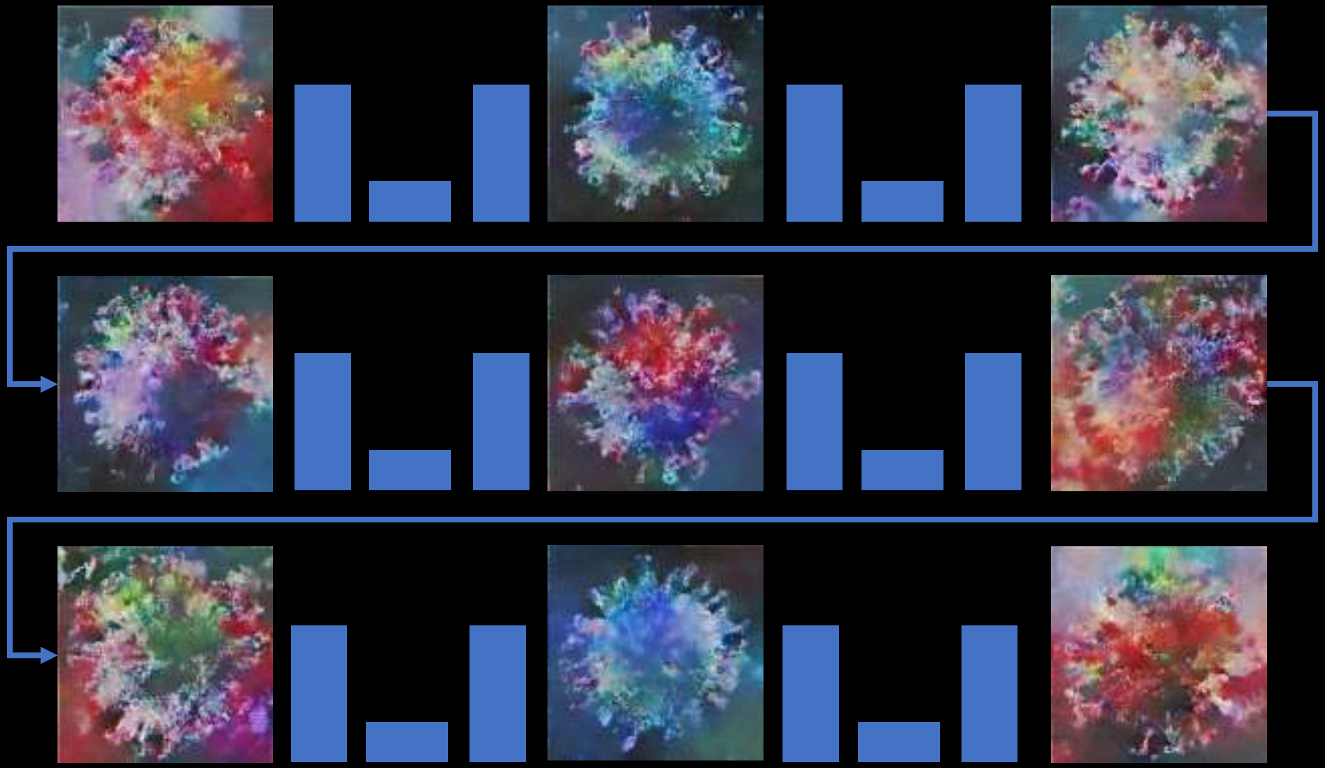


N. C. Rakotonirina and A. Rasoanaivo, "ESRGAN+ : Further Improving Enhanced Super-Resolution Generative Adversarial Network", 2020 IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP), pp. 3637-3641, 2020.

Multiple GPUs Parallel Computing



Extended Work: Gradual Change




Claude Monet [1840

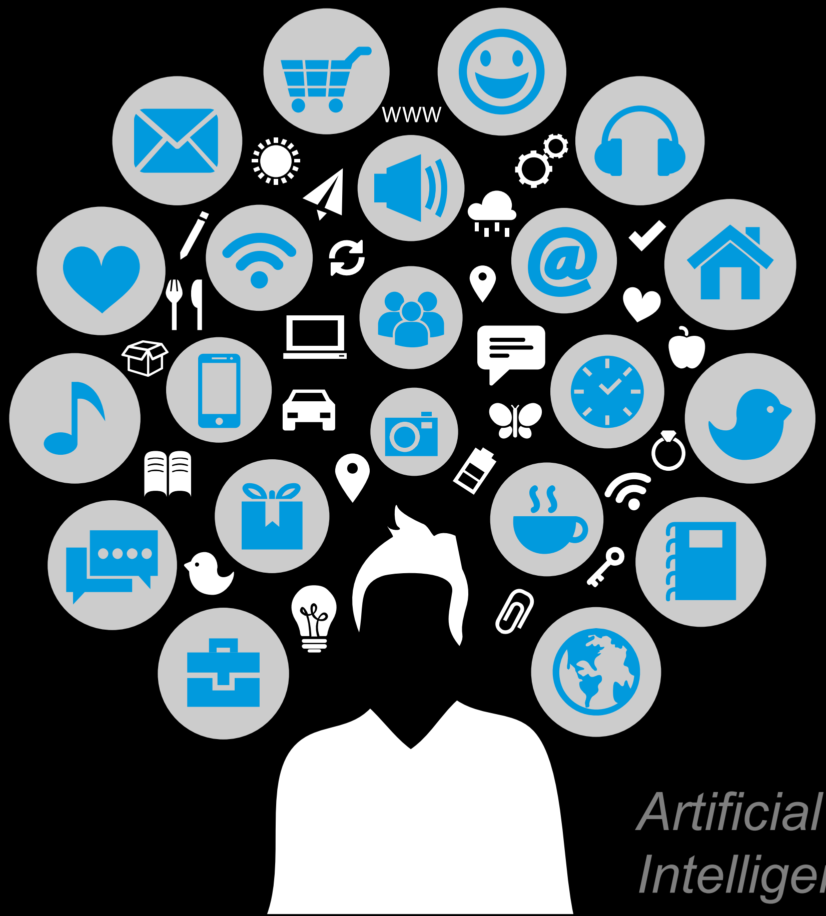

Pierre-Auguste Renoir [1841~1919]

01 Background

02 Art Statement

03 Method

04 Connection



Artificial Intelligence Art

Connection

METAVERSE

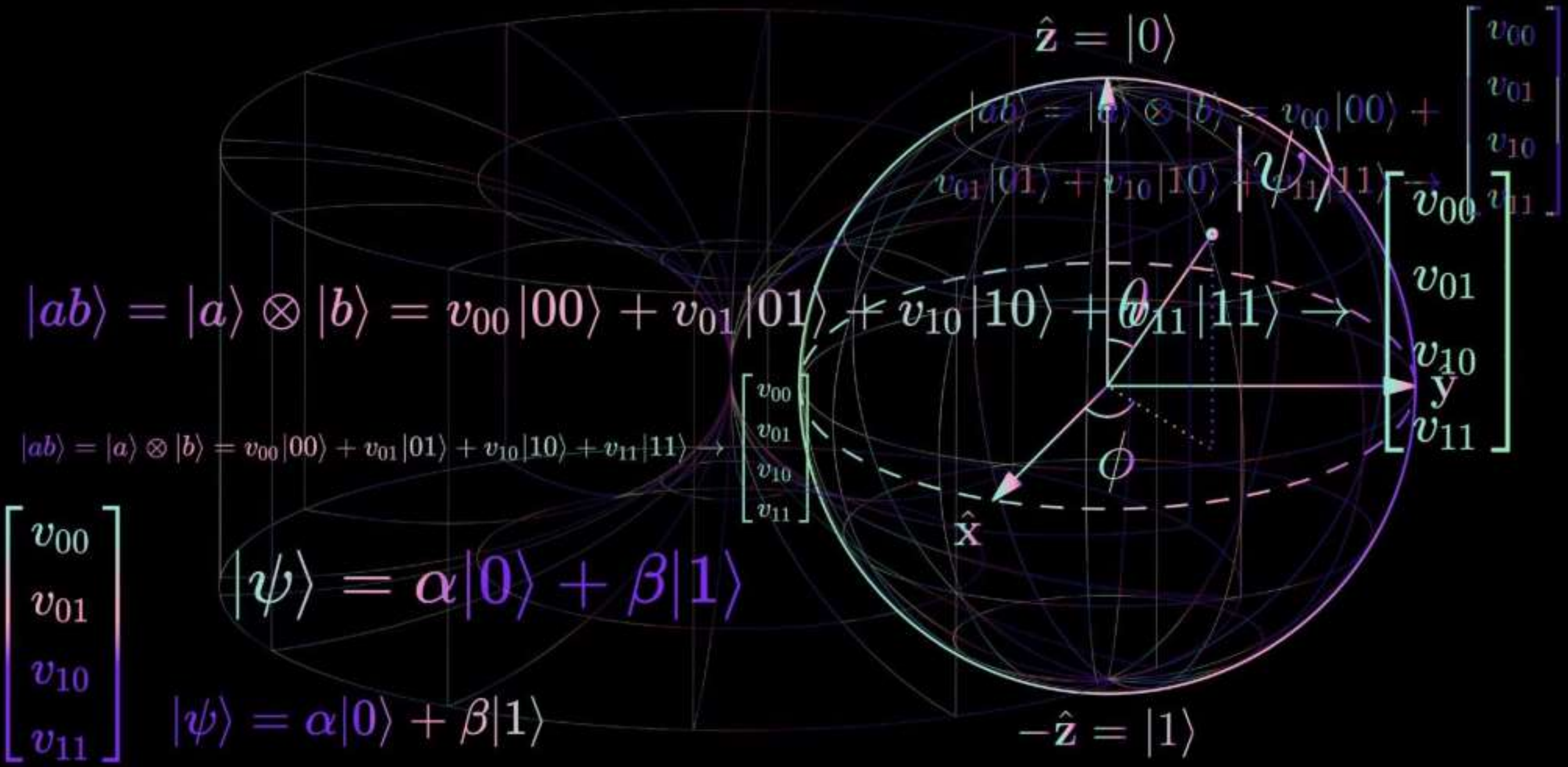
Quantum Computing

Meta-Universe

- Deepmind

Meta-Universe

Quantum Computing



Quantum Computing

$\mathbb{R}^N$ to the hypercube $[0, 2\pi]^{\otimes n}$. The i-th feature x_k is encoded into the k-th qubit via a Pauli-X rotation.

Figure 9 show the angle encoding with a rotation angle of θ around z-axis on the Hilbert space. After activation function $tanh(x)$, the output $x_k \in [-1, 1]$ from the end of classical layer. Then, the rotation angle is mapped between $\theta \in [0, \pi]$ due to the periodicity of the cosine function. This is relevant since the expectation value is taken with respect to the σ_z operator at the end of the circuit execution.

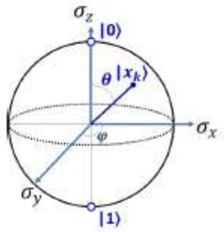


Figure 9: Angle encoding with a rotation angle of θ around z-axis on the Hilbert space.

3.2.2 Parametrized Quantum Circuit

A parameterized quantum circuit is a quantum circuit consisting of parameterized gates with fixed depth. These circuits have free parameters: the rotation angle of the quantum state. We use simple circuits and repeat multiple times with different random parameters, instead of using the large and complex classical neural networks. The parameterized quantum circuit also consists of one-qubit gates as well as Controlled Not (CNOT). Some more complicated gates may also be used in PQC which can be decomposed into one qubit gates and CNOT. In general, an n qubits PQC can be written as:

$$u(\hat{\theta})|\varphi\rangle = \left(\prod_{i=1}^{m} u_i\right)|\varphi\rangle \quad (7)$$

where $u(\hat{\theta})$ is the set of unitary gates and m is the number of quantum gate. $\hat{\theta}$ is the set of parameters $\{\theta_0, \theta_1, \ldots \theta_k\}$, where k is the total number of parameters and $|\varphi\rangle$ is the initial quantum state after data encoding. The unitary gate taking parameters is rotation gate $R(\hat{\theta})$, which are given by:

$$R_x(\hat{\theta}) = e^{-i\frac{\hat{\theta}}{2}\sigma_x}, R_y(\hat{\theta}) = e^{-i\frac{\hat{\theta}}{2}\sigma_y}, R_z(\hat{\theta}) = e^{-i\frac{\hat{\theta}}{2}\sigma_z} \quad (8)$$

where $\{\sigma_x, \sigma_y, \sigma_z\}$ is Pauli matrices. The operation of u can be modified by changing parameters $\hat{\theta}$. Thus, the output

achieve better entanglement of the qubits before appending nonlinear operations, the n qubits PQC has n repeated layers in our model. By optimizing the parameters, the general PQC tries to approximate arbitrary states so that it can be used for different specific molecules.

In order to provide computational speedup by orchestrating constructive and destructive interference of the amplitudes in quantum computing, we constructed m rotation gates R_x on the n qubits PQC as our basic quantum circuit, which can be written as:

$$\prod_{i=0}^{n}(\otimes_{j=0}^{m} R_x(\theta_{i+n\times j})\ CNOT_{i,i+1}) \quad (9)$$

where R_x represents the unitary gate of rotation-x. $\theta_{i+n\times j}$ is adjustable parameter of unitary gates. $CNOT_{i,i+1}$ represents $CNOT$ gate with m as the control qubit, and n is the total number of qubits. Figure 10 show the basic quantum circuit with n=4 and m=3. Each qubit uses the rotation gate $R(\theta)$ by the angle θ around x-axis on the Hilbert space, and $CNOT$ gate is used for every 2 qubits in order.

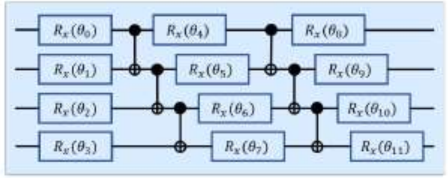


Figure 10: Basic quantum circuit with n=4, m=3

3.3. Fully Connection Layer

After obtaining all features from PQC, we feed them into a fully connection (FC) layer. We use the softmax activation function, so the output of FC layer will be a probability distribution. The i-th element of the output is the probability that this data point belongs to the i-th category, and we predict that this data point belongs to the category with the highest probability. In order to predict the actual label, we calculate the cumulative distance between the predicted label and the actual label as the loss function to be optimized:

$$\mathcal{L}(\omega^1, b^1, \theta, \omega^2, b^2) = -\frac{1}{N}\sum_{i=1}^{N}\sum_{j=1}^{K} y_j^i \log \tilde{y}_j^i \quad (10)$$

where ω^1, b^1 is the parameter of classical layer. θ is the parameter of quantum layer. ω^2, b^2 is the parameter of FC layer. Perform the above procedure enough times to get a

Thank You
Q&A

Reporter: IPHD, YuanFu Yang