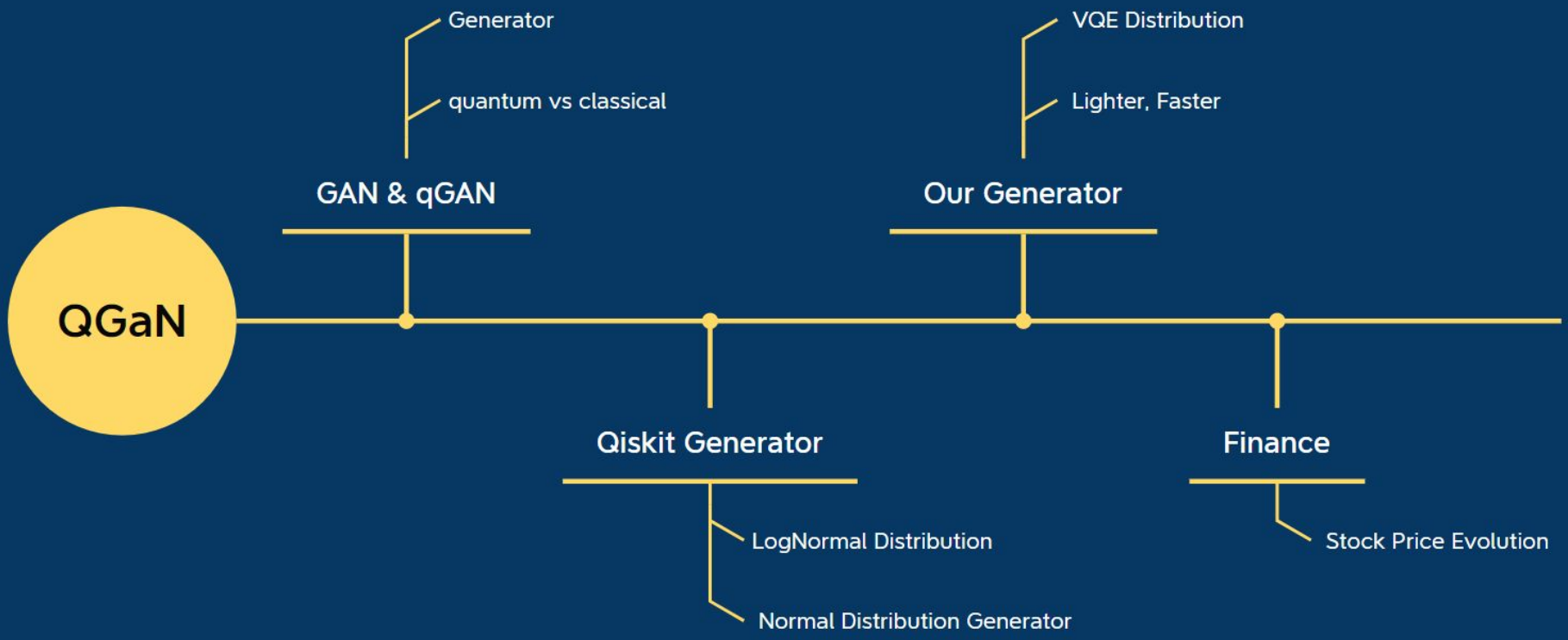
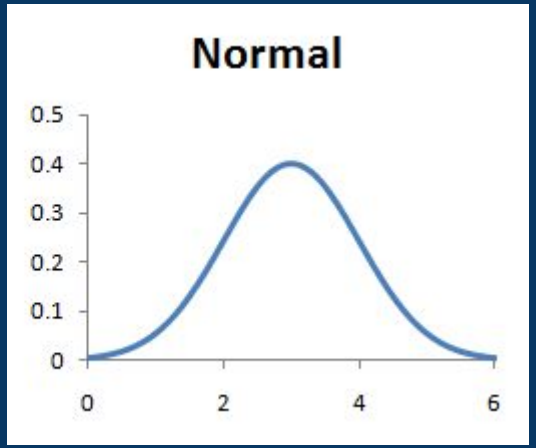
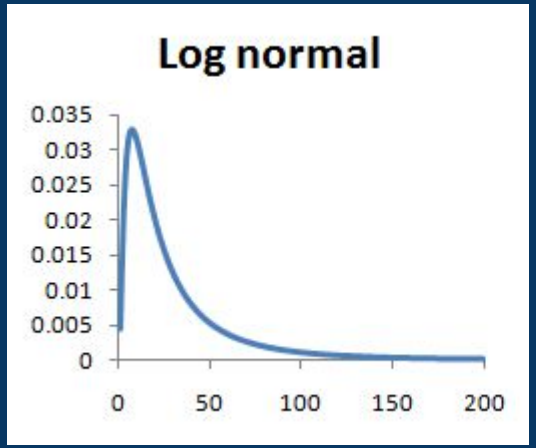
QUANTUM LOADER

Arbitary-Distribution Loader and Furthur Applications build with QGaN

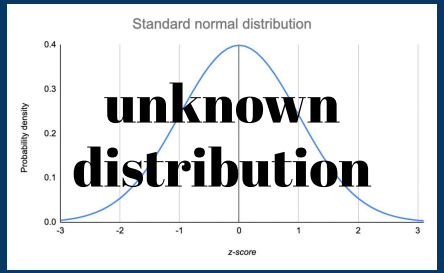

QGaN
GAN & qGAN
Generator
quantum vs classical
Our Generator
VQE Distribution
Lighter, Faster
Qiskit Generator
LogNormal Distribution
Normal Distribution Generator
Finance
Stock Price Evolution

Some common Distributions





Generator



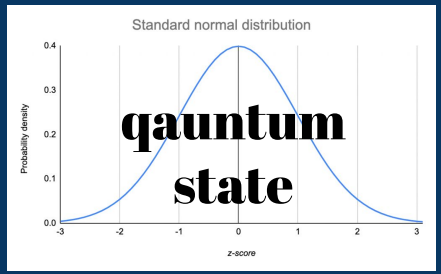
The work we want to do.

$$|\Psi\rangle = \sum_{i=0}^{N} a_i |\Psi_i\rangle$$

=

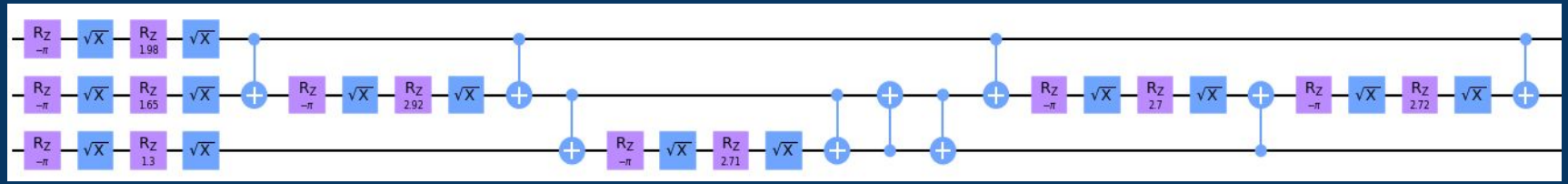
Data

G



LogNormal Distribution Generator

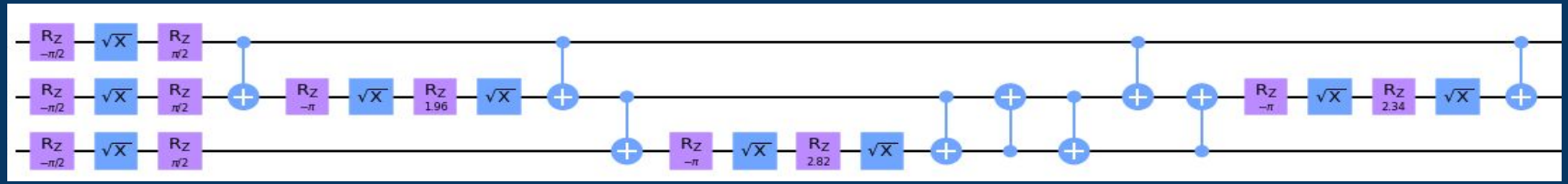
Quantum Circuit on real device



28 single gates, 9 cnot gates

Normal Distribution Generator

Quantum Circuit on real device

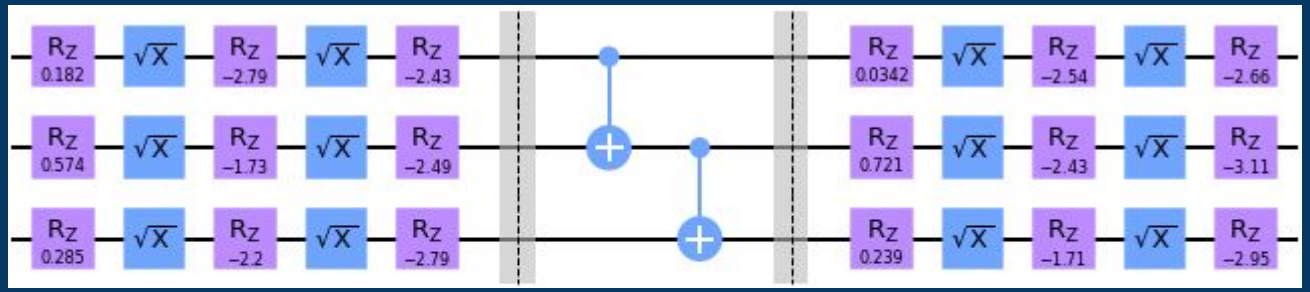


22 single gates, 9 cnot gates

VQE Distribution Generator

== Our Version ==

Quantum Circuit on real device

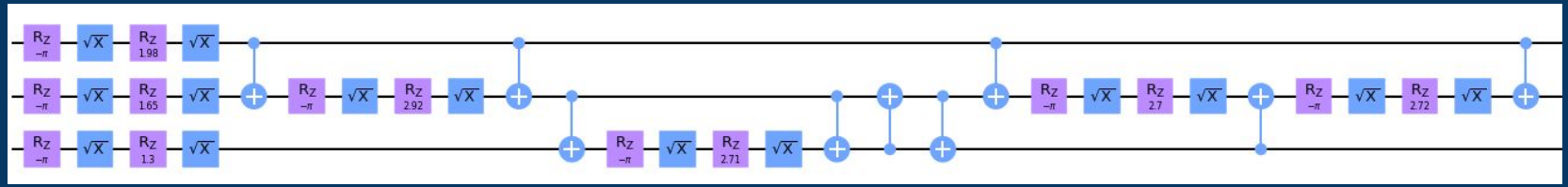


30 single gates, 2 cnot gates

runtime = 7.8s

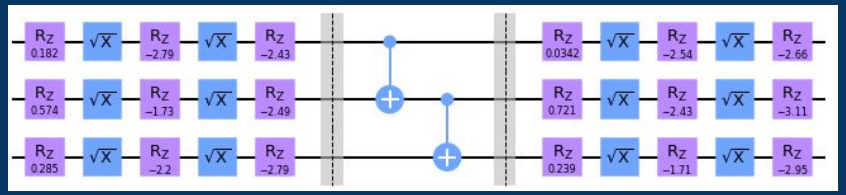
runtime = 5.4s

Qiskit version v.s Our version



LogNormal Distribution

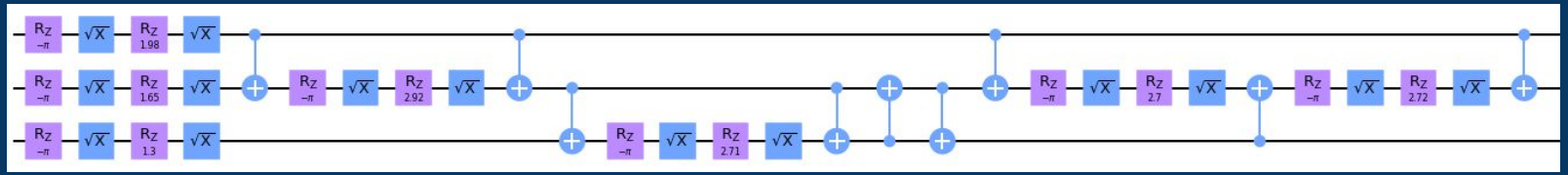
Can Approximately Simulate



VQE Ansatz

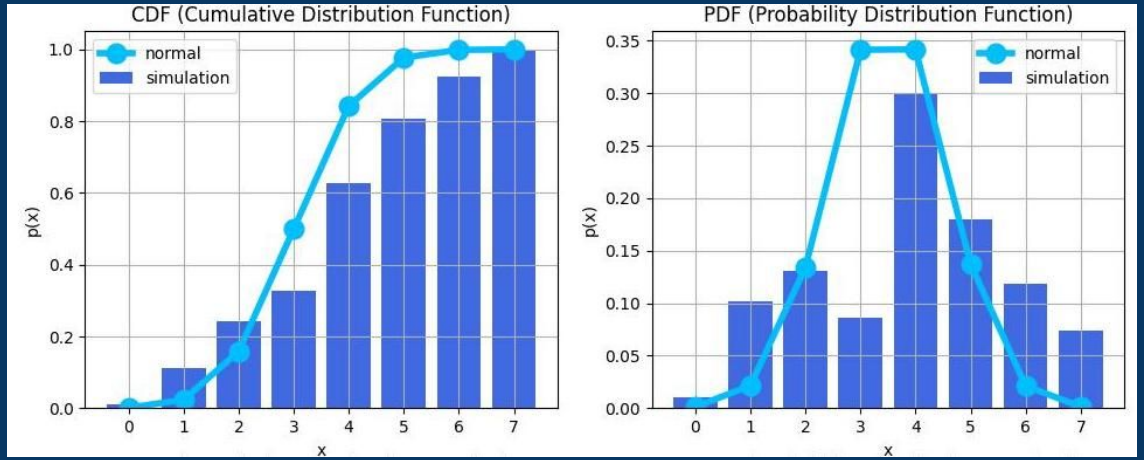
Can Approximately Simulate

Normal Distribution



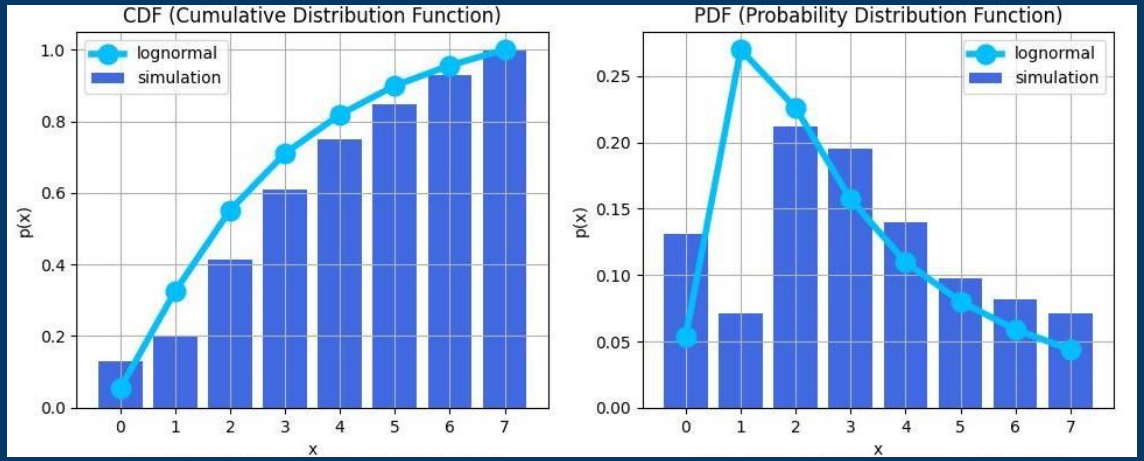
Normal

relative entropy = 0.7544



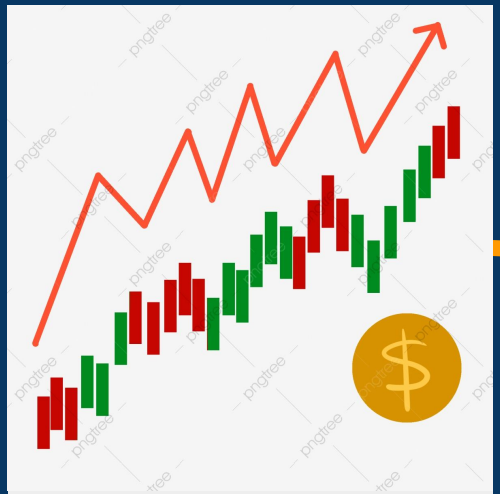
LogNormal

relative entropy = 0.1675



Quantum Loader Application: Pricing Option Problem

New: Sampling Real Stock Price Evolution (1 month)

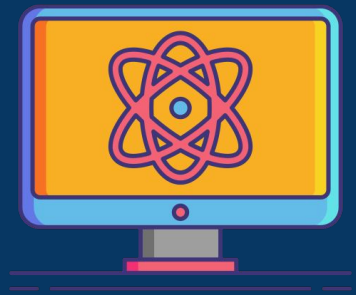


Stocks with initial price in $129~$131

real stock data~ log-normal distribution

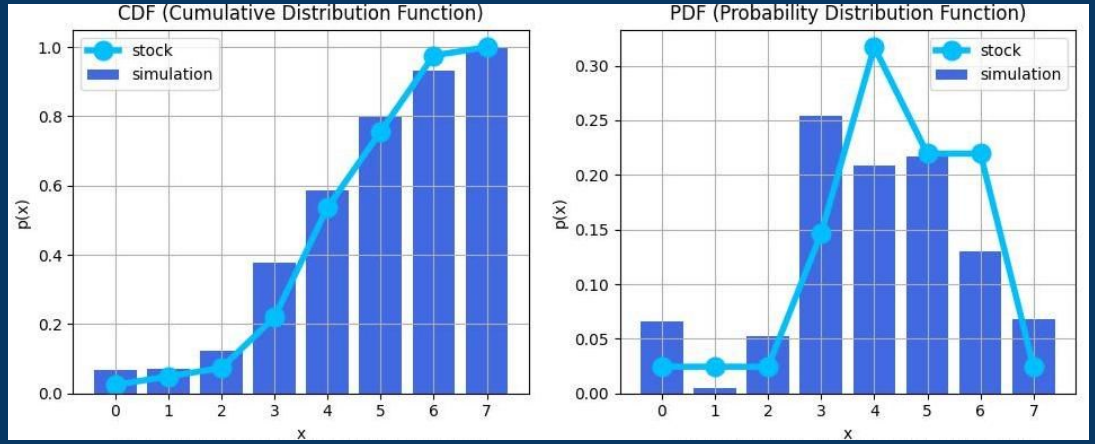
Applying QGaN - Read in the Real Stock Price Distribution

Train with qGAN



Our result

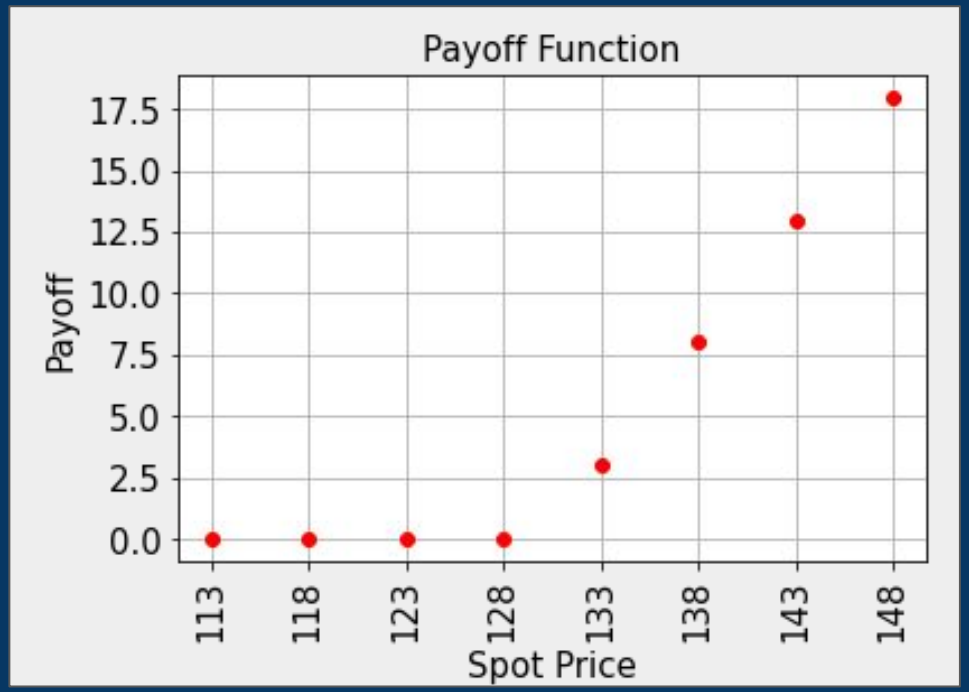
relative entropy = 0.1492



Steps in Price Option problem:

	Distribution Load into Quantum state	Data Sampling
Classical Method	– –	Classical Monte Carlo (Higher query complexity)
Quantum Full Circuit	Circuit Too Deep	Quantum Amplitude Estimation
VQE Ansatz	Shallow	Quantum Amplitude Estimation

Delta Value Calculation: Exact vs Estimation(QGaN+QAE)

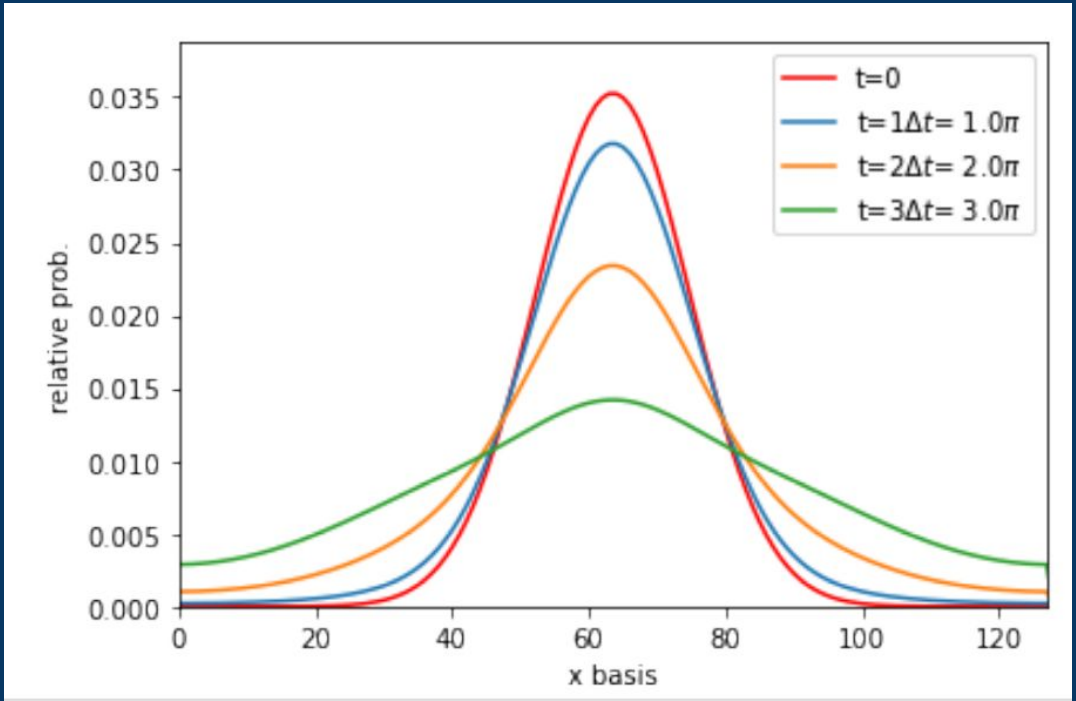


Exact Value : 5.42

Estimation by QGaN+QAE : 5.53

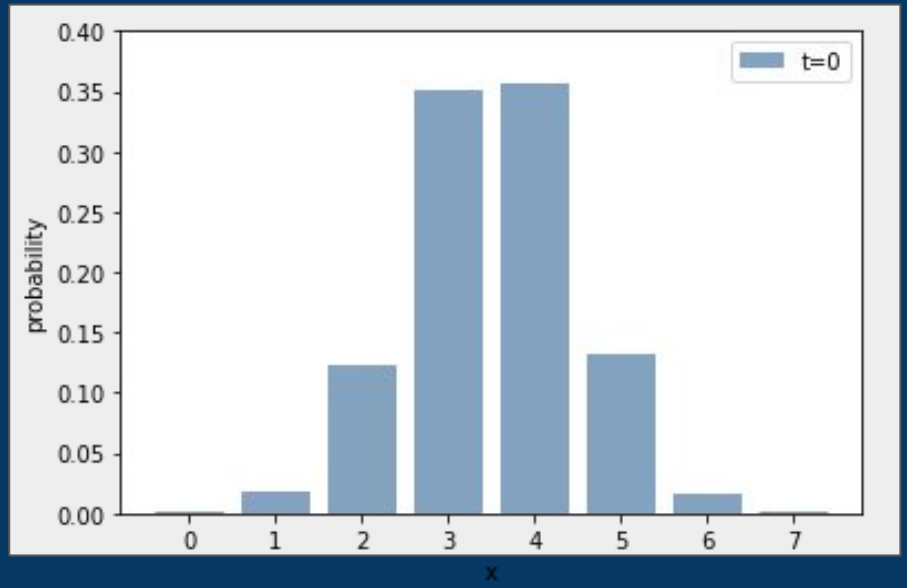
Application(2): Quantum Simulation for Free Particles

Dispersion of a Free Particle Wave Packet



Approimation+Encoding to Qubits

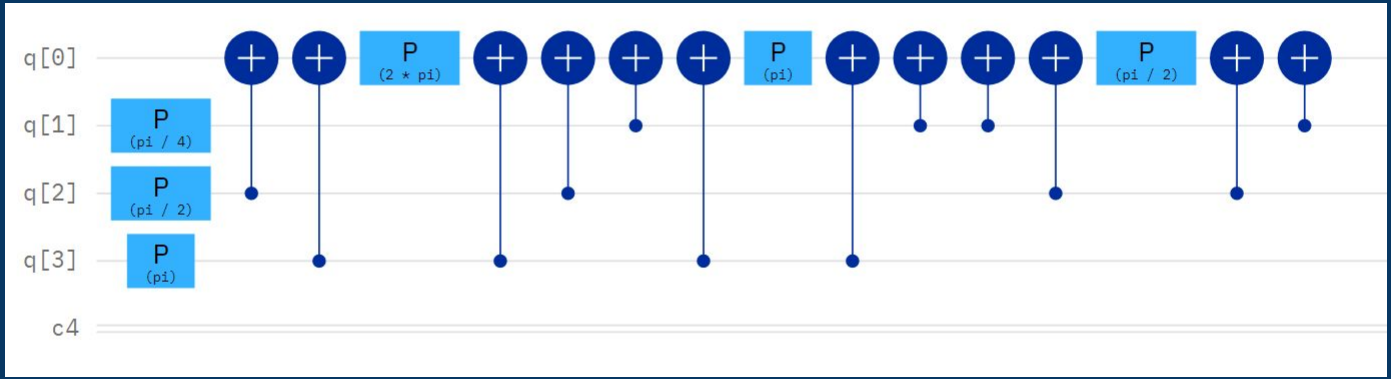
$$|\psi\rangle \approx \sum_{k=-d/\Delta x}^{d/\Delta x} a_k \, |k\Delta x\rangle$$



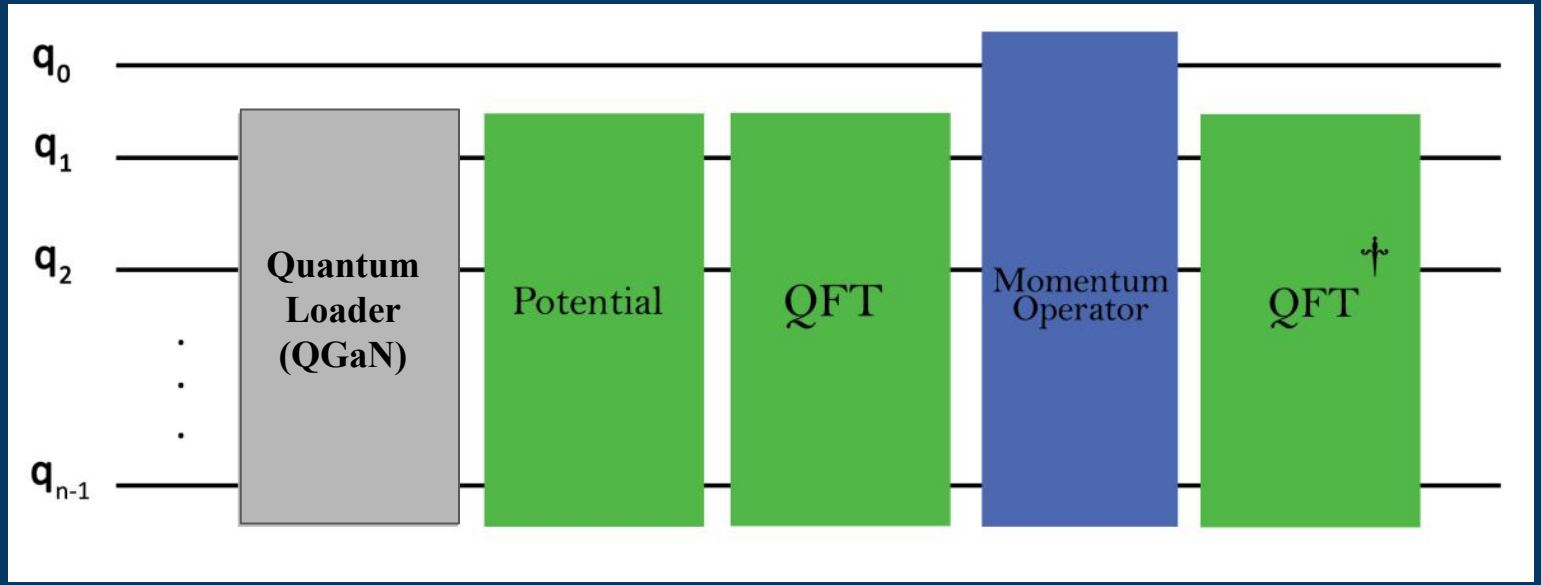
System Hamiltonian enocoding:

$$|\psi(t)\rangle = QFT^{-1} e^{-\frac{i}{\hbar}\left(\frac{p^2}{2m}\right)\Delta t} QFT\, e^{-\frac{i}{\hbar}V(x)\Delta t} |\psi_{init}\rangle$$

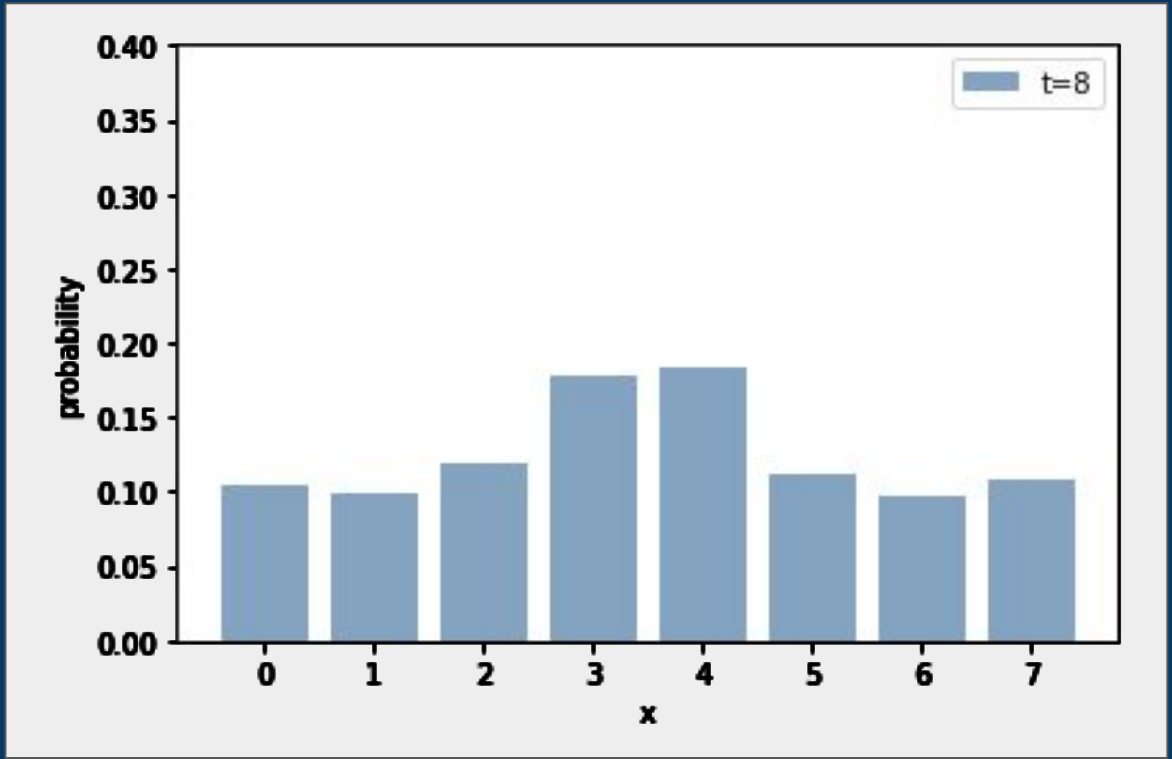
Construct Kinetic Energy Part in Momentum basis of states :



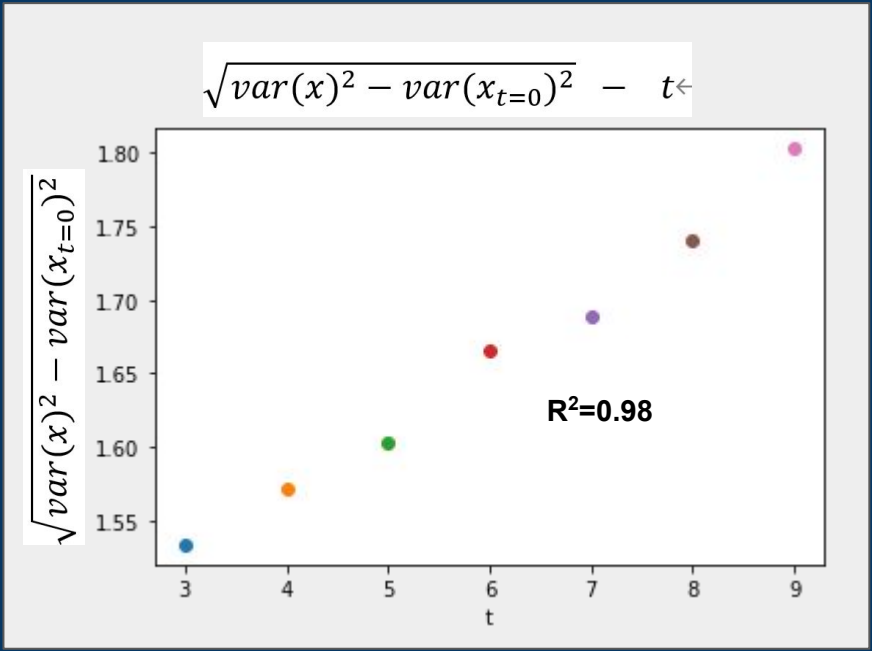
Where is our QGaN



Result: Evolution though times



Match the prediction of Schordinger Eq ！



$$\sigma(t) \equiv \sigma\sqrt{1 + (t/\tau)^2}$$

Conclusion

The three qubits states we prepare by QGaN is able to discrible and solve to real problems, with shallower gate depth, shows the potential of this methods.

Price options problem:
We test on our distribution(real data) different from log-normal(original paper) to varify our loader.

Dynamics problem:
Our loader have the capability to load guassian distribution correct enough to successfully simulate this dynamics.